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# *The Influence of Numerical Ability and Abstract Thinking on Mathematical Problem Solving*

## *Pengaruh Kemampuan Numerik dan Berpikir Abstrak terhadap Kemampuan Pemecahan Masalah Matematika*

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### **Abstract**

*This research is ex post facto that aims to examine the influence of numerical ability and abstract thinking on mathematical problem-solving skills of eighth-grade students of SMP in Palopo. The population of this research is the student's class VIII students in Palopo, totalling 212 students, but the sample is 70 students have amounted to 10 students from each class. The selection of the samples used was a proportional random sampling technique. The research instrument used is the numerical ability test, abstract thinking test, and mathematics problem-solving test. The data was obtained by statistical analysis of descriptive and inferential statistics. The result of this research is an influence of numerical ability and abstract thinking on the mathematics problem-solving ability of eighth-grade students of SMP in Palopo. Numerical knowledge and abstract thinking have a contribution effect of 44.1% on students' mathematics problem-solving abilities.*

**Keywords:** *Abstract Thinking; Mathematics Problem Solving; Numerical Ability.*

### **Abstrak**

*Penelitian ex post facto ini bertujuan mengkaji pengaruh kemampuan numerik dan berpikir abstrak terhadap kemampuan pemecahan masalah matematika siswa kelas VIII di salah satu SMP di Palopo. Populasi dalam penelitian ini adalah siswa SMP kelas VIII yang berjumlah 212 siswa, terbagi dalam 7 kelas. Sampel penelitian berjumlah 70 siswa yang dipilih dari 10 orang dari masing-masing kelas secara proporsional random sampling. Instrumen penelitian yang digunakan adalah tes kemampuan numerik, tes berpikir abstrak dan tes pemecahan masalah matematika. Data yang diperoleh dianalisis dengan analisis statistika deskriptif dan statistika inferensial. Hasil penelitian menunjukkan terdapat pengaruh kemampuan numerik dan berpikir abstrak terhadap kemampuan pemecahan masalah matematika siswa kelas VIII di salah satu SMP di Kota Palopo. Kemampuan numerik dan berpikir abstrak memiliki pengaruh kontribusi sebesar 44,1% terhadap kemampuan pemecahan masalah matematika siswa.*

**Keywords:** *Berpikir Abstrak; Kemampuan Pemecahan Masalah; Kemampuan Numerik.*

## **Introduction**

Problem-solving ability is one of the objectives of learning mathematics. Students learn mathematics to have good problem-solving skills to solve problems experienced in everyday life. Problem-solving ability in mathematics is the ability of students to solve mathematical problems by focusing on finding answers based on problem-solving steps. Mathematical problem-solving

ability is the process of finding a solution to a given mathematical problem by involving previously learned knowledge.<sup>1</sup>

The ability to solve problems varies from one student to another<sup>2</sup>. Several factors influence this difference. One of the factors that influence mathematical problem solving is numerical ability. Numerical ability has an essential role in students' learning and mathematical knowledge<sup>3</sup>, Developing numeric skills will help students to solve problems adequately<sup>4</sup>.

Numerical ability is defined as performing arithmetic operations quickly and precisely<sup>5</sup>. Completing calculation problems will be easier when students have good numerical skills. This ability helps students analyse mathematical problems logically and consistently and supports solving the problems given. The results of the research by Gunur, Makur, and Ramda. Furthermore, a large study concluded that there was a significant effect of numerical ability on students' problem-solving abilities<sup>6</sup>.

In addition to numerical ability, one factor affecting students' mathematical problem-solving skills is the ability to think abstractly. Mathematics is a science with an abstract object of study, so solving mathematical problems requires conceptual thinking skills<sup>7</sup>. Abstract thinking ability can be interpreted as a person's ability to think logically<sup>8</sup> by using symbols<sup>9</sup>. Students who have good abstract thinking skills will find it easier to describe mathematical situations/problems to be solved. It because the ability to think abstractly will require students to visualize, imagine, or represent a given problem<sup>10</sup>.

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<sup>1</sup> Ahmad Yogi, "Proses Asimilasi Dan Akomodasi Mahasiswa Bergaya Kognitif Field Independent Dalam Menyelesaikan Masalah Geometri," in *Prosiding Seminar Nasional*, vol. 04, 2018, 394–403.

<sup>2</sup> Sitti Zuhaerah Thalbah, "Profil Kemampuan Mahasiswa Tadris Matematika Dalam Memecahkan Masalah Program Linear Ditinjau Dari Perbedaan Tingkat Kemampuan Prasyarat Dan Gaya Kognitif Fiel Dependent," *Al-Khwarizmi: Jurnal Pendidikan Matematika Dan Ilmu Pengetahuan Alam* 6, no. 1 (2018): 29–46, <https://doi.org/10.24256/jpmipa.v6i1.397>.

<sup>3</sup> Annemie Desoete and Jacques Grégoire, "Numerical Competence in Young Children and in Children with Mathematics Learning Disabilities," *Learning and Individual Differences* 16, no. 4 (2006): 351–67, <https://doi.org/10.1016/j.lindif.2006.12.006>.

<sup>4</sup> Desoete and Grégoire.

<sup>5</sup> S.P Robbins, *Perilaku Organisasi* (Jakarta: Indeks, 2006).

<sup>6</sup> Saiful Akbar, "Pengaruh Kecerdasan Numerik Dan Kemampuan Pemecahan Masalah Terhadap Kemampuan Pemecahan Soal Rekreasi Matematika," *ALFARISI: Jurnal Pendidikan MIPA* 1, no. 2 (2020): 218–27, <https://journal.lppmunindra.ac.id/index.php/alfarisi/article/view/5670>.

<sup>7</sup> Farida Nurhasanah, "Abstraksi Siswa SMP Dalam Belajar Geometri Melalui Penerapan Model Van Hiele Dan Geometers; Sketchpad" (Universitas pendidikan indonesia, 2010).

<sup>9</sup> Lyli Rohanita Hasibuan and Rohani, "Pengaruh Pembelajaran Problem Posing Berkelompok," *Jurnal Education and Development* 7, no. 4 (2019): 284–88.

<sup>10</sup> Rima Guntari Lyana, Nyoman Sridana, and Nani Kurniati, "Hubungan Kemampuan Berpikir Abstrak Dan Kesiapan Belajar Terhadap Prestasi Belajar Matematika Siswa Kelas VIII-

The results of Hasibuan, Mukhtar, and K's research concluded that students who have high abstract thinking skills have higher mathematics learning outcomes than students who have low conceptual thinking abilities<sup>11</sup>. Furthermore, Lyana, Sridana, and Kurniati concluded that there is a positive relationship between abstract thinking ability and students' mathematics learning achievement, so that if abstract thinking ability increases, learning achievement will also increase.<sup>12</sup>

The results of an interview with the mathematics teachers showed; (1) Students who have good arithmetic operations skills tend to have good mathematical numerical abilities so that they are more able to solve the problems given, (2) Students with good abstraction skills tend to be easy to understand the mathematical material given so that they have good math skills.

Based on the description, this research examines the effect of numerical ability and abstract thinking on mathematics problem-solving for class VIII students in a private junior high school in Palopo. The difference between this research and previous research is that this study examines the numerical ability and problem-solving ability, abstract thinking and problem-solving skills, and numerical and abstract thinking skills of students together on students' problem-solving skills. Therefore, the results of this study are expected to be a reference for teachers in knowing students' mathematical problem-solving abilities through their numerical skills and abstract thinking.

## Method

This research is ex-post facto research that aims to see the effect of numerical ability and abstract thinking on eighth-grade students' mathematical problem-solving in a private junior high school in Palopo. The population in the study was all students of class VIII Junior High School for the academic year 2020/2021, totaling 212 students divided into seven classes. The sample in this study amounted to 70 students. The selected sample consists of 10 students who represent each class. The sample selection technique used is the proportional random sampling technique.

Data collection techniques using test techniques. The numerical ability test aims to measure students' numerical ability. The form of the numerical ability test used in this study is multiple choice. This test indicator (1) performs mathematical calculations, (2) thinks logically, (3) solves a problem, (4) recognizes patterns and relationships between numbers. Abstract thinking

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5 SMPN 5 Mataram Tahun Pelajaran 2017/2018," *Indonesian Journal of STEM Education* 1, no. 2 (2019): 74-77.

<sup>11</sup> Lily Rohanita Hasibuan, Mukhtar, and Abdul Hamid K, "Pengaruh Strategi Pembelajaran Dan Kemampuan Berpikir Abstrak Terhadap Hasil Belajar Matematika," *Jurnal Teknologi Pendidikan* 11, no. 2 (2018): 167-81.

ability test aims to measure students' conceptual thinking ability. The form of abstract thinking test used in this research is an essay. The indicators of this test are (1) introduction, (2) Representation, (3) Structural Abstraction, (4) structural awareness. The mathematical problem-solving ability test aims to measure students' mathematical problem-solving abilities. The form of the mathematical problem-solving ability test used in this study is an essay. The test indicators (1) understand the problem, (2) draw up a settlement plan, (3) carry out the settlement plan, (4) check the results. The data collected will be analyzed using descriptive statistical analysis and inferential statistical analysis with the help of the IBM SPSS Statistics 20 application program. Inferential statistics used are simple linear regression to test the hypothesis. The first hypothesis is that numerical thinking ability influences math problem solving for class VIII students in a private junior high school in Palopo, and it was analyzed using a simple linear regression test. The second hypothesis is that abstract thinking ability affects mathematics problem solving for class VIII students in a private junior high school in Palopo, which is analyzed using simple linear regression and multiple linear regression. There are three research hypotheses, namely:

- a. Hypothesis 1; the effect of numerical thinking ability on mathematics problem solving for class VIII students in a private junior high school in Palopo, analyzed using a simple linear regression test.
- b. Hypothesis 2; the effect of abstract thinking ability on mathematics problem solving for class VIII students in a private junior high school in Palopo, analyzed using a simple linear regression test.
- c. Hypothesis 3; there is an effect of numerical ability and abstract thinking on math problem solving for class VIII students in a private junior high school in Palopo. It was analyzed using the multiple linear regression test Palopo and the multiple linear regression test with prerequisite tests, namely normality and linearity tests.

## Results and Discussion

### 1. Students' Numerical Ability

An overview of the numerical abilities of grade VIII students in a private junior high school in Palopo can be seen in the following table.

Table 1. Descriptive Statistics of Numerical Ability of Class VIII Students in a Private Junior High School in Palopo

No	Variable	Statistical Value
1	Many Samples	20
2	Average	55,57
3	median	60
4	Standard Deviation	19,38
5	Variance	375,75
6	Range	29,16
7	Minimum Value	20
8	Maximum Value	90
9	mode	60

Source: Primary data analysis results (2021)

The students' numerical ability data were further categorized into five groups. Based on this categorization, the distributive frequency and percentage of the numerical ability of class VIII students in a private junior high school in Palopo are obtained as follows.

Table 2. Frequency Distributive of Numerical Ability of Class VIII Students in a Private Junior High School in Palopo

No	Interval	Frequency	Percentage (%)	Category
1	$0 \leq x < 55$	34	48,5	Very low
2	$55 \leq x < 65$	13	18,6	Low
3	$65 \leq x < 80$	9	12,9	Medium
4	$80 \leq x < 90$	10	14,3	Tall
5	$90 \leq x \leq 100$	4	5,7	Very high
	Total	70	100	

Source: Primary data analysis results (2021)

Based on Tables 1 and 2, it can be seen that the numerical ability of Class VIII students of SMP in Palopo is still relatively low. Students who have low skills are 37 students. The low numerical ability of students is due to the difficulty in solving questions related to logical thinking, solving problems and questions regarding pattern relationships between numbers due to the lack of students practicing answering questions. Learning is not optimal, which results in a lack of students understanding the material provided, which results in students' abstract abilities being low. Utami and Cahyono suggest that in the online learning process, students are not accustomed to carrying out online learning needs at home; students learn math material according to

what they want. given by the teacher, not what they need, the goals or targets of students' online learning for mathematics lessons are still limited to obtaining satisfactory grades, not the abilities they should improve<sup>12</sup>.

## 2. Students' Abstract Thinking Ability

The description of the abstract thinking ability of class VIII students in a private junior high school in Palopo shows in the following table.

Table 3. the Descriptive Statistics of Abstract Thinking Ability of Class VIII Students in a Private Junior High School in Palopo

No	Variable	Statistical Scores
1	Samples	70
2	Average	56,14
3	median	55,00
4	Standard Deviation	11,36
5	Variance	129,11
6	Range	45
7	Minimum Value	35
8	Maximum Value	80
9	Mode	55

Source: Primary data analysis results (2021)

Data on students' abstract thinking abilities were further categorized into five groups. Based on this categorization, the distributive frequency of abstract thinking of class VIII students in a private junior high school in Palopo is obtained as follows.

Table 4. Frequency Distribution of Abstract Thinking Ability of Class VIII Students in a Private Junior High School in Palopo

No	Interval	Frequency	Percentage (%)	Category
1	$0 \leq x < 55$	27	38,6	Very low
2	$55 \leq x < 65$	22	31,4	Low
3	$65 \leq x < 80$	18	25,7	Currently
4	$80 \leq x < 90$	3	4,3	Tall
5	$90 \leq x \leq 100$	0	0	Very high
Total		70	100	

Source: Primary data analysis results (2021)

Based on Tables 3 and 4, it can be seen that the students' abstract thinking ability is low. The low capacity of students' abstract thinking, because most students have difficulty in doing Representations, some have problems in doing Structural Abstraction and structural awareness. The COVID-19

<sup>12</sup> Yuliza Putri Utami and Derius Alan Dheri Cahyono, "Study At Home: Analisis Kesulitan Belajar Matematika Pada Proses Pembelajaran Daring," *Jurnal Ilmiah Matematika Realistik* 1, no. 1 (2020): 20-26, <https://doi.org/10.33365/ji-mr.v1i1.252>.

pandemic has made learning mathematics done online and not optimally, resulting in students' abstract abilities being low. According to Dasa and Hudaidah, the lack of online mathematics learning during the pandemic is that students find it difficult to understand abstract mathematical material and require direct visualization.<sup>13</sup>

### 3. Students' Mathematical Problem-Solving Ability

An overview of the mathematical problem solving abilities of class VIII students in a private junior high school in Palopo shows in the following table.

Table 5. Descriptive Statistics of Problem-Solving Ability of Class VIII Students in a Private Junior High School in Palopo

No	Variable	Statistical Scores
1	Samples	70
2	Average	63,37
3	median	75
4	Standard Deviation	5,10
5	Variance	26,03
6	Range	20,45
7	Minimum Value	65,91
8	Maximum Value	86,36
9	Mode	75

Source: Primary data analysis results (2021)

Data on students' mathematical problem-solving abilities were further categorized into five groups. Based on this categorization, the distributive frequency of solving math problems for class VIII students in a private junior high school in Palopo is obtained below.

Table 6. Frequency Distribution of Problem-Solving Abilities of Class VIII Students in a Private Junior High School in Palopo

No	Interval	Frequency	Percentage (%)	Category
1	$0 \leq x < 55$	0	0	Very low
2	$55 \leq x < 65$	0	0	Low
3	$65 \leq x < 80$	60	85,7	Currently
4	$80 \leq x < 90$	10	14,3	Tall
5	$90 \leq x \leq 100$	0	0	Very high
Jumlah		70	100	

Source: Primary data analysis results (2021)

<sup>13</sup> Zahra Alhumairah Basa and Hudaidah, "Perkembangan Pembelajaran Daring Terhadap Minat Belajar Matematika Siswa SMP Pada Masa Pandemi COVID-19," *Edukatif: Jurnal Ilmu Pendidikan* 3, no. 3 (2021): 943-50, <https://edukatif.org/index.php/edukatif/article/view/461>.



Based on Tables 5 and 6, students' problem-solving abilities are classified as moderate, and this is because most students have difficulty in compiling a given problem-solving plan. This is in line with Buschman's opinion that the challenges experienced by students are because the strategies used are unusual and inefficient.<sup>14</sup>

#### 4. Results of Inferential Statistical Analysis

The purpose of inferential statistical analysis is to test the research hypotheses that have been formulated. Before testing the hypothesis, the prerequisite tests are carried out, namely the normality and linearity tests. The following are the results of the normality test of research data.

Table 7. Normality Test Results

Variable	Kolmogorov-Smirnov <sup>a</sup>		
	Statistic	Df	Sig.
Numerical ability(X1)	0,105	70	0,055
Abstract Thinking(X2)	0,091	70	0,200
Troubleshooting(Y)	0,095	70	0,192

Based on the results of the normality test with Kolmogorov-Smirnov the probability value for numerical ability data (X1) is  $0.055 > 0.05$ , for abstract thinking ability data (X2) is  $0.200 > 0.05$ , and for mathematical problem-solving data (Y) is  $0.192 > 0.05$  which means that numerical ability data, abstract thinking ability data and mathematical problem-solving data usually distributed.

The linearity test of the students' numerical and mathematical problem-solving abilities obtained a sig value. Deviation from linearity is  $0.228 > 0.05$ , which means that it has a significant linear relationship between students' numerical ability (X1) and mathematical problem solving (Y). linearity test of abstract thinking and mathematical problem-solving ability of students obtained sig. Deviation from linearity is  $0.062 > 0.05$ , which means that it has a significant linear relationship between abstract thinking (X2) and students' mathematical problem solving (Y).

Hypothesis 1 test was conducted to see the relationship between numerical ability and students' mathematical problem-solving ability. The statistical hypotheses are:

<sup>14</sup>Jatmiko, "Kesulitan Siswa Dalam Memahami Pemecahan Masalah Matematika," *Jurnal Ilmiah Pendidikan Matematika* 3, no. 1 (2018): 17-20.

H0: There is no effect of numerical ability on the mathematical problem-solving ability of class VIII students in a private junior high school in Palopo.

H1: There is an effect of numerical ability on the mathematical problem-solving ability of eighth-grade students in a private junior high school in Palopo.

Based on the results of hypothesis 1 testing, a probability value of  $0.001 < 0.05$ , which means H0 rejected, and H1 is accepted, so it can be concluded that there is an influence of numerical ability on the mathematical problem-solving ability of eighth-grade students in a private junior high school in Palopo. The R square value of 0.136 was obtained, so it was interpreted that numerical ability had a 13.6% contribution effect on the mathematical problem-solving ability of class VIII students in a private junior high school in Palopo and 86.4% was influenced by other factors outside of numerical ability. Numerical skills are the basic skills that students need to solve problems in mathematics. The results of research by Gunur, Makur, and Ramda concluded that the better a person's numerical skills, the better his problem-solving ability. Furthermore, the research results of Ramadhan, Suaedi & Ilyas found that students who have high numerical skills tend to have high mathematical problem-solving abilities as well.

Hypothesis 2 test was conducted to see the relationship between abstract thinking and students' mathematical problem-solving abilities.

H0: There is no effect of abstract thinking on the mathematical problem-solving ability of class VIII students in a private junior high school in Palopo.

H1: There is an effect of abstract thinking on the mathematical problem-solving ability of class VIII students in a private junior high school in Palopo.

Based on the results of hypothesis 2 testing, a probability value of  $0.000 < 0.05$  means that H0 is rejected and H1 is accepted so that it can be concluded that there is an effect of abstract thinking on the mathematical problem-solving ability of VIII students in a private junior high school in Palopo. It also obtained an R square value of 0.440 so that it interpreted that abstract thinking had a 44% contribution effect on the mathematical problem-solving ability of class VIII students in a private junior high school in Palopo, and 56% was influenced by other factors outside of abstract thinking. Wijayanti expressed similar results, abstract thinking is one of the competencies required for

mathematics students to develop abstract thinking skills; one is expected to be able to find solutions to complex problems.<sup>15</sup>

Hypothesis 3 test was conducted to see the relationship between numerical ability and abstract thinking with students' mathematical problem-solving ability. The statistical hypotheses are:

H0: There is no effect of numerical ability and abstract thinking on the mathematical problem-solving ability of class VIII students in a private junior high school in Palopo.

H1: There is an effect of numerical ability and abstract thinking on the mathematical problem-solving ability of eighth-grade students in a private junior high school in Palopo.

<sup>3</sup> Based on the results of hypothesis testing 3, the probability value of  $0.000 < 0.05$ , which means that H0 is rejected and H1 is accepted, it can be concluded that there is an effect of numerical ability and abstract thinking on the mathematical problem-solving ability of eighth-grade students in a private junior high school in Palopo. The adjusted R square value is 0.434, so it is interpreted that numerical ability and abstract thinking have a 43.4% contribution effect on the mathematical problem-solving ability of class VIII students in a private junior high school in Palopo, and 56.6% is influenced by other factors outside numerical ability and abstract thinking.

Based on the discussion above, Numerical ability and abstract thinking ability influence mathematical problem-solving ability because numerical ability will assist students in carrying out the settlement plan, namely the completion process that involves calculations. Students will have difficulty solving mathematical problems if they do not have sufficient numerical abilities. Students who have good abstract thinking skills are easier to describe situations/problems in mathematics. This is in line with Nurhasanah because the object of mathematical study is abstract, so mathematical solving problems requires the ability to think abstractly. The results of Hasibuan, Mukhtar, & K's research, abstract thinking skills that lead to mathematics lessons, in particular, will positively affect students' mathematical ability<sup>16</sup>.

## Conclusion

<sup>4</sup> Based on the results of research and discussion, it can be concluded that 1) the numerical ability of class VIII students in a private junior high school in Palopo influences mathematical problem-solving abilities with a contribution of 13.6%, 2) abstract thinking abilities of class VIII students in one private

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<sup>15</sup> Ana Susac et al., "Development of Abstract Mathematical Reasoning: The Case of Algebra," *Frontiers in Human Neuroscience* 8, no. SEP (2014), <https://doi.org/10.3389/fnhum.2014.00679>.

<sup>16</sup> Hasibuan, Mukhtar, and K, "Pengaruh Strategi Pembelajaran Dan Kemampuan Berpikir Abstrak Terhadap Hasil Belajar Matematika."

junior high school in Palopo influences mathematical problem-solving ability with a contribution of 44%, and 3) Numerical ability and abstract thinking influence the mathematical problem-solving ability of eighth-grade students in a private junior high school in Palopo with an influence contribution of 43.4%.

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