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# The Effect of Spatial Ability on the Mastery of Mathematical Concepts for Class VIII MTs Nahdlatul Mujahidin NW Jempong

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***Abstract***

Spatial ability includes students' skills to understand in depth the relationship between objects and space, so that it can help improve students' understanding of concepts. Spatial ability is a type of skill that requires high-level thinking processes in imagining geometrical architecture through a strong imagination. These skills can make it easier for students to master mathematical concepts in order to solve problems correctly. This study aims to determine the effect of mathematical spatial ability on students' conceptual mastery. This study uses a quantitative approach with a type of expost facto research. The instrument used consisted of a test of spatial ability in the form of multiple choice with a total of 20 items, while to determine the mastery of students' concepts, a description test of 5 items was used. This research was conducted at MTs Nahdlatul Mujahidin NW Jempong with a population of class VIII and a sample of 25 students from class VIII A and class VIII B. $t_{count}$ = 0.90, consequently $t_{count}$ is greater than $t_{table}$, then $H_a$ is accepted. Based on the determination test, it is known that the value of $R^2$ = 0.81. This means that spatial ability can affect students' mastery of concepts by 81%, while 19% is influenced by other factors not examined. The regression equation is $Y = 37.88 + 0.63X$ which indicates that there is a positive effect.

**Keywords:** Spatial Ability, Concept Mastery, Build Space

**Abstrak**

Kemampuan spasial memuat keterampilan siswa untuk memahami secara mendalam hubungan antara objek dan ruang, sehingga dapat membantu meningkatkan pemahaman konsep siswa. Kemampuan spasial termasuk jenis keterampilan yang membutuhkan proses berpikir tingkat tinggi dalam membayangkan arsitektur geometri melalui daya imajinasi yang kuat. Keterampilan tersebut dapat memudahkan siswa menguasai konsep matematika agar dapat menyelesaikan masalah dengan tepat. Penelitian ini bertujuan mengetahui pengaruh kemampuan spasial matematika terhadap penguasaan konsep siswa. Penelitian ini menggunakan pendekatan kuantitatif dengan jenis penelitian *expost facto.* Instrumen yang digunakan terdiri atas tes kemampuan spasial berupa pilihan ganda dengan jumlah 20 butir soal, sedangkan untuk mengetahui penguasaan konsep siswa menggunakan tes uraian sebanyak 5 butir soal. Penelitian ini dilakukan di MTs Nahdlatul Mujahidin NW Jempong dengan populasi kelas VIII dan sampel sebanyak 25 siswa dari kelas VIII A dan kelas VIII B. Berdasarkan uji hipotesis diketahui nilai kemampuan spasial mengunakan Uji *t* dengan taraf signifikan 5% diperoleh $t_{tabel}$ = 2,06, sedangkan $t_{hitung}$ = 0,90, akibatnya $t_{hitung}$ lebih besar daripada $t_{tabel}$, maka $H_a$ diterima. Berdasarkan uji determinasi diketahui bahwa nilai $R^2$ = 0,81, ini berarti kemampuan spasial dapat berpengaruh terhadap penguasaan konsep siswa sebesar 81%, sedangkan 19% dipengaruhi oleh faktor lain yang tidak diteliti. Dengan persamaan regresinya adalah $Y = 37,88 + 0,63X$ yang menunjukkan bahwa terdapat pengaruh yang positif.

**Kata kunci:** Kemampuan Spasial, Penguasaan Konsep, Bangun Ruang



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## INTRODUCTION

Education has an important role in developing students' cognitive processes (Rosa, 2015). The government issued a policy regarding education as stated in the National Education System Law No. 20 in chapter II article 3 of 2003, namely: "National education functions to develop capabilities and shape character and civilization in the context of educating the nation's life, aiming to develop the potential to become a human being. who believes and fears God Almighty, has a noble character, is healthy, knowledgeable, handsome, creative, independent, and democratically and responsibly

citizens." Through these regulations, education is one of the main components that contribute greatly to the progress of a nation (Hidayati, 2017; Karimah, 2018).

Education, especially in Indonesia, can be categorized as lacking when compared to developed countries (Elvira, 2021; Leonard, 2016). This is because the existing system prioritizes the results rather than the learning process. Education that does not prioritize the process will only produce a generation that tends to want to make progress in an instant way (Fakhruddin, 2014). Such a generation is certainly very easily influenced by liberal cultures, does not know the rules, a generation that is lazy, less creative, and consumptive. The benchmark for assessing students is not only seen through the results but also the process (Sulistiani, 2016; Sumintono & Widhiarso, 2015). However, the facts that emerge are phenomena that are contrary to the ultimate goal of the educational process, especially in learning mathematics (Fakhruddin, 2014).

Mathematics learning as learning that is systematically arranged, where the previous material is interrelated with the material that will be the next discussion (Rikanah & Winarso, 2016). In mathematics lessons, students are required to be able to think abstractly because the object of discussion is not faced directly (Sulistiani, 2016; Wahyuningtyas & Shinta, 2017). In learning mathematics, higher-order thinking processes are needed, because students are directed to learn to use their cognitive domain optimally by presenting objects to students through responses, ideas, or symbols (Djidu & Jailani, 2016; Hidayati, 2017). Therefore, the habit of thinking in abstract contexts is very necessary to know, identify, and project perception results in mathematics learning, especially in geometry material (Rikanah & Winarso, 2016; Wahyuningtyas & Shinta, 2017).

Geometry is one of the mathematical materials that requires good mathematical ability to understand (Maarif, 2013). The purpose of learning mathematics, especially geometry material, is to develop logical thinking skills, impart knowledge that supports further mathematical material, teach how to read and interpret mathematical arguments, and develop contextual spatial intuition (Kusuma, 2020; Rahmawati, 2011). As for the background behind the existence of geometry learning in schools so that students can get used to using visualization and support the maximum spatial ability of students (Putri, 2020).

Spatial ability is a skill that includes spatial relationships (the ability to observe the relationship of object positions in space), projective relationships (the ability to see objects from various points of view), distance conservation (the ability to estimate the distance between two points), frames of reference (benchmarks for determining the position of objects in space), spatial representation (the ability to represent spatial relationships by manipulating cognitively), and mental rotation (the ability to imagine rotating objects) (Alimuddin & Trisnowali, 2018). Spatial ability is a type of skill that requires high-level thinking processes in imagining geometric architecture through a strong imagination (Saputra, 2018). Thus, spatial ability is a very important skill to be mastered by students because it is closely related to cognitive aspects in general and academic achievement (Saputra, 2018; Utami, 2020).

Spatial ability is also needed to reveal the world of visual space precisely and accurately (Putri, 2020). It is proven that in spatial ability there are skills to recognize the shape of an object, perform cognitive transformations and recognize these changes, imagine then pour it into real form, and present data in the form of graphs, relations, lines, colors, and spaces (Siswanto, 2016; Utami, 2020). So of course, this ability is very important to master in order to make it easier for students to learn geometric concepts (Siswanto, 2016).

The mathematical concepts that have been taught by the teacher make it sometimes difficult for students to illustrate geometric shapes (Farisdianto & Budiarto, 2014). Geometric material, on the other hand, has the potential to be easier for students to understand because students have recognized geometric shapes since elementary school, and students are no strangers to geometric-shaped objects in everyday life (Farisdianto & Budiarto, 2014; Utami, 2020).But even so, the fact is that in the field of geometry, it is one of the materials that students lack mastery of.

The statement above is also supported by the results of observations and interviews with teachers and students of MTs Nahdlatul Mujahidin NW Jempong, which revealed that students perceive mathematics as a scary lesson. Most students have difficulty understanding mathematics, especially geometric material, because some formulas and concepts are not easily understood. Students tend not to have good mastery of the material to support their ability to learn mathematics. This is caused by many factors, including the different mathematical abilities of students. So that the impact on the mathematics scores obtained by students is still below the minimum completeness criteria (KKM) or in the low category. This fact is based on data on mid-semester test scores obtained by researchers from schools.

Through the description above, in understanding mathematical concepts, especially geometric geometry, preparation is needed to support students' conceptual abilities. One of them is by conducting a study to see what factors influence students' mastery of mathematical concepts. As for this research, it is focused on whether spatial ability influences students' mastery of concepts. This is because spatial ability can make it easier for students to find solutions to problems, so students can solve problems appropriately (Saputra, 2018). Therefore, the hypothesis of this study is that if students have good spatial abilities, it is also possible for these students to have good mastery of mathematical concepts.

Several previous studies have attempted to reveal the context of the discussion as it relates to students' spatial abilities and conceptual mastery. Saputra's research (2018) discusses in detail mathematical spatial abilities. Research by Anisa et al. (2017) applies discovery learning to increase student motivation and mastery of concepts. Utami's research (2020) conducted an analysis of student errors in solving problems based on mathematical spatial abilities. The research of Andriani et al. (2017), namely the implementation of discovery learning to improve students' metacognitive abilities and mastery of concepts. Farisdianto & Budiarto's (2014) research on the profile of junior high school students' ability to solve geometric problems is seen from the difference in mathematical ability.

Based on the previous studies above, there has not been a study that examines the effect of spatial ability on students' mastery of concepts in geometry material. This is a strong foundation for researchers to focus on the study of the research context. Thus, researchers need to research to reveal whether there is an influence of spatial ability on students' mastery of mathematical concepts in flat-sided geometry at MTs Nahdlatul Mujahidin NW Jempong.

## METHOD

This type of research uses an expost facto quantitative approach, which is a correlation study. Researchers are trying to find information about why there is a causal relationship, while the statistical analysis technique used to test the research hypothesis is the product-moment correlation test. This research was conducted at MTs Nahdlatul Mujahidin NW Jempong class VIII and included a sample of 25 students from classes VIII A and VIII B. In this study, the independent variable was the mathematical spatial ability (*X*), while the dependent variable was the mastery of geometric concepts of flat-sided shapes. (*Y*). Broadly speaking, the design of this research is described as follows.

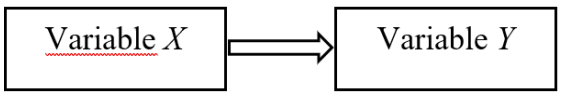


Figure 1. Research Design

The instruments used in this research are a spatial ability test sheet and a test of the ability to solve geometrical geometry problems. The two research instruments have been validated by material and learning experts and have been empirically tested. The data collection techniques include documentation, tests, and interviews.

The data analysis technique in this study was used in two ways, namely prerequisite tests, and hypothesis testing. The prerequisite test uses normality and homogeneity tests, while the hypothesis test uses correlation analysis and regression analysis. Correlation analysis is used to find the direction and strength of the contribution of understanding the prerequisite material (*X*) to the mastery of the geometric concept of flat-sided geometry (*Y*). The formula used in the correlation analysis is the product-moment correlation. As for being able to provide an interpretation of the correlation coefficient obtained, the researchers are guided by the following provisions.

Table 1. Guidelines for Interpretation of Correlation Coefficients

| **Interval** | **Category** |
|---|---|
| 0,000-0,199 | Very low |
| 0,200-0,399 | Low |
| 0,400-0,599 | Currently |
| 0,600-0,799 | Strong |
| 0,800-1,000 | Very strong |

Furthermore, simple regression analysis was taken to predict how far spatial ability affects

students' mastery of geometric concepts. The general simple regression equation used is $Y = a + b.X$ with *Y* (the dependent variable), *X* (the independent variable), and a and b (constants).

## RESULT AND DISCUSSION

### *Result*

This research was conducted on existing data without any treatment given to students. The researcher did not apply to learn about mathematical spatial abilities and geometric concepts for students. This is because the learning is carried out by the teacher in the field of mathematics studies so that students get geometry materials, especially the flat side space from the teacher. Then the researchers obtained valuable data related to students' spatial abilities and conceptual mastery through test results after learning mathematics was carried out. Furthermore, the value data is tested for prerequisites and hypotheses, which are described as follows.

### Prerequisite test

The data to be tested for normality is the data from the spatial ability test and the data from the students' concept mastery. Both sets of data were tested for normality using the chi-square test. The results of the calculation of the normality test on students' spatial abilities can be seen in table 2.

Table 2. Data of Students' Spatial Ability Normality Test Result

| **Interval Class** | **Class Limit** | **Z Class Limit** | **Area Z Table** | $f_o$ | $f_h$ | $\frac{(f_o - f_h)^2}{f_h}$ |
|---|---|---|---|---|---|---|
| | 29,5 | -2,20 | | | | |
| 30 – 37 | | | 0,0582 | 1 | 1,455 | 0,142 |
| | 37,5 | -1,46 | | | | |
| 38 – 45 | | | 0,1637 | 6 | 4,0925 | 0,889 |
| | 45,5 | -0,72 | | | | |
| 46 – 53 | | | 0,2602 | 6 | 6,505 | 0,039 |
| | 53,5 | 0,01 | | | | |
| 54 – 61 | | | 0,2694 | 6 | 6,735 | 0,080 |
| | 61,5 | 0,75 | | | | |
| 62 – 69 | | | 0,1585 | 4 | 3,9625 | 0,0003 |
| | 69,5 | 1,49 | | | | |
| 70 – 77 | | | 0,0556 | 2 | 1,39 | 0,2676 |
| | 77,5 | 2,24 | | | | |
| | $x^2 hitung$ = | | | | | 1,4173 |

Based on the calculation of the normality test, obtained $x^2$count = 1.4173. While the value of $x^2$table with = 5% and dk = 6-3 = 3 is 7.815. Thus, the information obtained $x^2$count < $x^2$table. The results of these calculations prove that the spatial ability data obtained is normally distributed. Furthermore, the researchers conducted a normality test on the data from the students' concept mastery test results, which can be seen in table 3.

Table 3. Data on the Normality Test Results of Students' Concept Mastery

| **Interval Class** | **Class Limit** | **Z Class Limit** | **Area Z Table** | $f_o$ | $f_h$ | $\frac{(f_o - f_h)^2}{f_h}$ |
|---|---|---|---|---|---|---|
| | 55,5 | -2,28 | | | | |
| 56 – 60 | | | 0,0481 | 3 | 1,2025 | 2,686 |
| | 60,5 | -1,56 | | | | |
| 61 – 65 | | | 0,1411 | 1 | 3,5275 | 1,810 |
| | 65,5 | -0,84 | | | | |
| 66 – 70 | | | 0,2557 | 8 | 6,3925 | 0,404 |
| | 70,5 | -0,11 | | | | |
| 71 – 75 | | | 0,1819 | 4 | 4,5475 | 0,065 |
| | 75,5 | 0,60 | | | | |
| 76 – 80 | | | 0,1775 | 8 | 4,4375 | 2,860 |
| | 80,5 | 1,30 | | | | |
| 81 – 85 | | | 0,0766 | 1 | 1,915 | 0,437 |
| | 85,5 | 2,05 | | | | |
| | | $x^2 hitung =$ | | | | 8,262 |

Based on the calculation of the normality test in table 3, the information obtained is $x^2$count = 8,262. While the value of $x^2$table with = 2% and dk = 6-3 = 3 is 9.84. Thus, we get the terms $x^2$count < $x^2$table. Through the test results, it can be stated that the data from the students' concept mastery tests is normally distributed.

After conducting a normality test on the data from the spatial ability test and the students' mastery of concepts, the researcher then conducted a homogeneity test to determine whether the data variance of the analyzed sample was homogeneous or not. The results of the calculation of the normality test using the manual method are as follows.

$$F_{count} = \frac{\text{Largest Variance}}{\text{Least Variance}} = \frac{4{,}04}{3{,}09} = 1{,}307 \quad (1)$$

Based on the above calculation, the results of the homogeneity test with a = 5% and dk = 15, with manual calculations, obtained the value of $F_{count} < F_{table}$ or 1.30 < 2.39. Thus, it can be stated that the two sets of research data, namely the results of the spatial ability test and the students' mastery of concepts, are homogeneous.

**Hypothesis Testing**

The first step that the researcher takes in testing the hypothesis is to perform a correlation analysis through the Pearson product moment to determine the correlation coefficient. From the calculation results, the value of r obtained is 0.903. This explains why the correlation between spatial ability and students' conceptual mastery is positive and is in the very high category.

Through the description above, the results of the calculations that have been carried out are obtained by the value of $t_{count}$ = 0.90. This result is consulted with = 5%, the value of $t_{table}$ = 2.069 is obtained, then the fact is that $t_{count} > t_{table}$. This proves that spatial ability has a significant effect on mastery of the concept of flat side space. As for knowing the effect of variable *X* on *Y*, it can be seen

from the coefficient of determination r, namely $r^2 \text{x } 100\% = (0{,}90)^2 \text{ x } 100\% = 81\%$.. Thus, spatial ability contributes 81% to the mastery of students' concepts of geometrical geometry.

In the second step, the researcher conducted a simple regression analysis of the two student test data sets. The general formula for a simple linear regression equation is $Y$ = a + b$X$ with coefficients $a$ and $b$. The simple linear equation between spatial ability and students' mastery of concepts obtained from the calculation results is $Y$ = 37.88 + 0.63$X$. From this equation, if $X$ = 0 then the initial value of students' conceptual mastery is 37.88. These results indicate that if a student does not have the spatial ability, it is estimated that the student will get a score of 37.88 for mastering the concept of flat-sided geometry. This is because the $X$ coefficient is positive, which means the higher the value of spatial ability, the higher the mastery of students' concepts in the geometry of flat-sided geometry.

The researcher then tested the significance and linearity of the simple linear regression equation. Based on the data obtained from the students' spatial ability and concept mastery, it can be seen in table 4.

Table 4. ANOVA for $X$ and $Y$

| Source | Dk | JK | KT | F |
|---|---|---|---|---|
| Total | 25 | 129900 | 129900 | |
| Regression | 1 | 128737,44 | | |
| Regression (b\|a) | 1 | 945,9 | 945,9 | 100,4 |
| Residue | 25-2 | 216,7 | 9,421 | |
| Tuna is suitable | 6 | 68,6 | 11,43 | |
| Mistake | 17 | 148,1 | 8,71 | 1,31 |

From the results of the calculations that have been carried out, the value of $F_{count}$ = 1.31 is obtained. With a significant level of = 5% with k = 8 and n = 25, in order to obtain $F_{table}$ = 4.28, thus $F_{count} < F_{table}$. This means that the equation $Y$ = 37.88 + 0.63$X$ is linear. So it can be claimed that spatial ability has a significant effect on students' mastery of concepts.

After analyzing the final data, they proceed with hypothesis testing. This is done to determine whether there is an influence of spatial ability on students' mastery of concepts. The hypotheses of this research are as follows:

$H_0$ : There is no effect of spatial ability on students' mastery of concepts

$H_a$ : There is an effect of spatial ability on students' conceptual mastery

Based on the results of the calculations that have been carried out, the value of $t_{count}$ = 0.90 is obtained. This means that spatial ability has a positive influence on students' mastery of concepts by 81%. These results were consulted with a = 5%, the value of $t_{table}$ = 2.069, so that the fact $t_{count} > t_{table}$ was obtained. Thus, it can be seen that spatial ability has a significant effect on students' mastery of concepts, so $H_0$ is rejected or $H_a$ is accepted. Through the results of these tests, the hypothesis of this study was proven, namely that there was an influence of spatial ability on students' mastery of concepts in the geometry of flat-sided geometry.

### *Discussion*

Mathematics is one of the subjects that can support students' problem solving abilities in everyday life (Yustianingsih et al., 2017). In addition, students' ability in mathematics is very necessary, because it can be utilized in society (Sulistiani & Masrukan, 2016). This is in line with the goal of mathematics lessons, which is to prepare students to be able to face changing world conditions that are always evolving through continuous technological innovation (Mawaddah & Anisah, 2015).

Through learning mathematics, students are trained to think logically, critically, carefully, honestly, effectively, and efficiently (Yustianingsih et al., 2017). It can also support developing students' mindsets in making decisions about real-life problems. One of the branches of mathematics that is very closely related to real-life is geometry (Alimuddin & Trisnowali, 2018). Geometry is the study of points, lines, fields, and space objects and their properties, sizes, and relationships with one another (Utami, 2020). To learn geometry, students must have good enough mathematical abilities, so that it can make it easier for students to learn geometric concepts, specifically the shape of a flat side space (Saputra, 2018).

In addition to mathematical abilities, to make it easier for students to master spatial concepts, good spatial abilities are also needed (Saputra, 2018; Syahputra, 2013). Spatial ability is the skill to reveal the world of visual space, which includes the skill to recognize the shape of an object correctly (Saputra, 2018). Spatial ability is also a skill for imagining the geometric shapes of a building. Therefore, it is very important to master this ability to support the learning process carried out by students (Saputra, 2018; Utami, 2020).

Based on the results of research on students' spatial skills, it shows that the average level of students' spatial abilities is 53.6. This proves that the level of students' spatial ability is in the medium category. Meanwhile, the results of the student's concept mastery test have an average value of 71.76 which means they are at the level of interpretation with a good category. So it can be claimed that the spatial ability of students as a whole greatly affects the mastery of students' concepts.

Furthermore, through linear regression calculations with the provisions ($X$) as spatial ability, and ($Y$) as mastery of concepts, the equation $Y = 37.88 + 0.63X$ is obtained. The positive $X$ coefficient in the equation indicates that the higher the spatial ability, the higher the student's concept mastery ability. The percentage of the influence of spatial ability on student mastery is 81%. This fact shows that spatial ability has a high regression on students' conceptual mastery, which is in the interval of $0.80 \leq R^2 \leq 1.00$.

Seeing the description above, spatial ability does not 100% or fully affect students' ability to master mathematical concepts. However, the effect of spatial ability is only 81%. This is evidence that there are still 19% of other factors that influence students in mastering mathematical concepts. The results of this study are reinforced by Bahri's (2008) statement, which explains that the factors that influence learning outcomes include psychological and environmental factors.

Good spatial ability is very important for students because these skills are closely related to cognitive aspects in general (Saputra, 2018; Utami, 2020). This study confirms that spatial ability can affect student performance related to mathematical tasks, and has a positive impact on mathematical ability. Putri (2020) in her research also mentions that mathematics and spatial thinking skills have a positive correlation in students. Spatial ability not only has a relationship but also greatly influences math learning achievement, especially in the field of geometry (Saputra, 2018). The results of Putri's research (2017) found that spatial ability has a very positive effect on students' geometric abilities. Even if students' spatial abilities increase, the effect on students' geometry test scores will also increase.

## CONCLUSION

Based on the results and discussion of the research, it can be concluded that there is a positive influence of spatial ability on students' mastery of geometric concepts. This can be proven by the calculation results, namely the value of $t_{count}$ = 0.90, this result is consulted with = 5%, it is obtained the value of $t_{table}$ = 2.069 thus $t_{count} > t_{table}$. This means that spatial ability has a positive effect on the mastery of geometric concepts, while the percentage of the effect is 81%.

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