

Analysis of student's mathematical spatial abilities in solving geometric problems

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Abstract. This study aims to describe the mathematical spatial ability of students in solving mathematical problems. The research method used is the descriptive qualitative research method. Data collection techniques were carried out through tests, interviews, and documentation. The results of this study indicate that (1) students with a high level of mathematical spatial ability category can meet all the indicators of spatial ability that researchers use in this study (2) students with a category of moderate level of mathematical spatial ability can meet two of the four spatial ability indicators that researchers use. in this study (3) students with the low level of mathematical spatial ability, the category had difficulty fulfilling several indicators of spatial ability that the researchers used in this study.

Keywords: Spatial ability, Geometry

1 Introduction

Geometry is a branch of mathematics that has tremendous benefits. The existence of geometry and its application makes it easier to work in daily life, it also gives beautiful shapes that we can see around us. The closest example is the shape of our house, there is a combination of geometric shapes in it to make a beautiful and sturdy house. Various buildings in this world cannot be separated from the concept of geometry. Geometry makes the building beautiful with a balance of form and accuracy of measurement. The concept of measurement in this geometry makes very tall buildings stand strong and sturdy. This makes Geometry an important subject or course to learn [1].

Some experts define geometry, including according to Clements [2], geometry builds a concept starting with identifying shapes and investigating buildings and separating images such as

rectangles, circles and triangle. Ismiyani [2] states that geometry is an understanding of the concept of various geometric shapes, flat shapes and spatial shapes. Recognize the names and characteristics of the various geometric shapes and look for shapes that are similar to each of these shapes in the real world. Concrete learning of the objects he introduces makes it easier for

children to understand more quickly differences in shapes, characteristics and properties of an object. Geometry provides approaches to problem solving such as drawings, diagrams, coordinate systems, vectors, and transformations [3]. From some of these opinions, it can be concluded that geometry is an approach to solving a problem in recognizing the shape of objects, comparing, distinguishing, and also distinguishing the similarities and differences in the shapes of objects that are around.

This geometry material is included in learning mathematics from the elementary school level to the university level, especially the mathematics education study program. However, it is still a material that is considered difficult by students and students. This natural student difficulty certainly gave birth to low student scores in geometry courses. As shown in Table 1 below, these are the final semester exam scores for geometry students that the researcher took in the last 3 years.

Table 1. Average Student Final Exam Scores in Geometry Courses

Years	N	Average
2017/2018	38	60
2018/2019	40	55
2019/2020	42	65

Table 1 illustrates that students are very problematic in learning geometry, the average final semester test score for students in the last 3 years is in a low category. So there must be student efforts to be able to solve geometric problems. According to the National Academy of Science [4], it is stated that every student should try to develop his spatial abilities and senses which are very useful in understanding relations and properties in geometry.

The ability to solve problems Geometry is inseparable from spatial abilities. Ability is a talent that is acquired and possessed by individuals naturally to be able to complete certain tasks successfully[5]. Then according to the KBBI spatial is defined as something related to space or place. So the spatial bility according to Lestari & Yudhanegara suggests that mathematical spatial ability is the ability to imagine, compare, guess, determine, construct, represent, and determine information from visual stimuli in the context of space [6]. So with students having mathematical spatial abilities, it is hoped that students can improve their abilities and make it easier to solve geometric problems [7][8][9][10]. Meanwhile, according to Sefina the indicators of mathematical spatial ability are: 1) Orientation, identifying the shape or position of a geometric object viewed from a certain point of view, 2) Spatial visualization, constructing and representing geometric models drawn on a flat plane, 3) Spatial Perception, stating the position between elements in the form of space at a certain point of view, and 4) Disembedding, investigating a geometric object. Such hat this indicator is a competence that should be possessed by mathematics education students who leading to an increase in their competence in the field of geometry[10].

Based on the previous description, researchers are interested in analyzing more deeply related to students' mathematical spatial abilities in solving geometry problems.

2 Method

The place chosen by the researcher was Medan State University. The subjects of this research are 3rd students who take courses in field and space geometry. The number of subjects in this study were 38 students. The research method used in this research is descriptive qualitative research method. The instruments in this study were a test of mathematical spatial ability and interview items. The spatial ability test is given to students with 5 questions in the form of an essay test. This test is to categorize students at the level of mathematical spatial ability. The following is a rubric for assessing students' mathematical spatial abilities.

Table 2. Mathematical Spatial Ability Scoring Table

Score	Criteria
4	Can answer all aspects of questions about mathematical spatial abilities and be answered correctly and clearly or completely
3	Can answer almost all aspects of questions about communication and are answered correctly.
2	Can answer only some aspects of questions about communication and are answered correctly.
1	Inappropriate answer to aspects of the question about communication or drawing the wrong conclusion
0	Not Answer

Based on the scores that have been obtained by students, then students are categorized into 3 levels of mathematical spatial ability, namely having high, medium and low abilities with the following criteria[11].

Table 3. Mathematical spatial ability categorization table

Catagory	Range
High	$X > 66,67$
Medium	$33,33 < X \leq 66,67$
Low	$X < 33,33$

3 Result and Discuss

The results of students' mathematical spatial abilities are shown in table 4 below

Table 4. Mathematical spatial ability test results

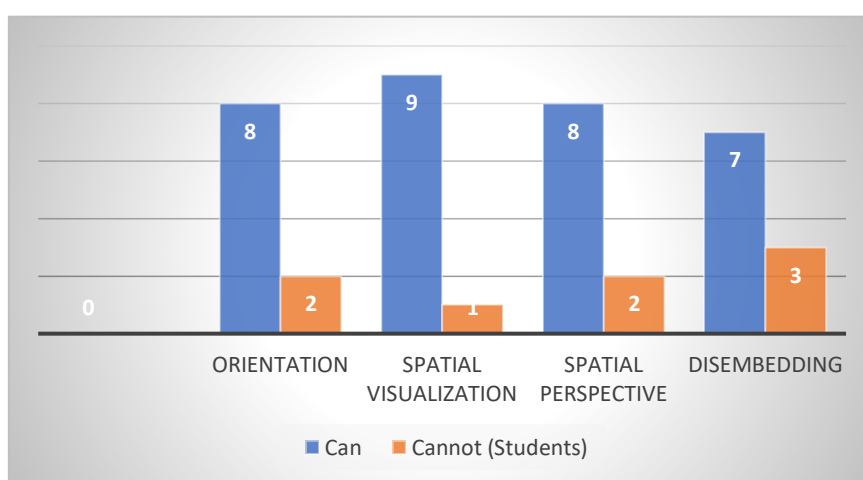
Catagory	range	Number of students
High	$X > 66,67$	10
Middle	$33,33 < X \leq 66,67$	9
Low	$X < 33,33$	19

From Table 4 it can be seen that the dominance of students' mathematical spatial abilities in solving geometric problems is still low. Of the 38 students studied, 18 students were in a low

category, 9 students were in the medium category and 10 students were in the high category. From each indicators of mathematical spatial ability can be described for each level of ability.

Table 5. Overview of aspects of high category spatial ability

Indicator	Can (Students)	Cannot (Students)
Orientation	8	2
Spatial Visualization	9	1
Spatial Perspective	8	2
Disembedding	7	3



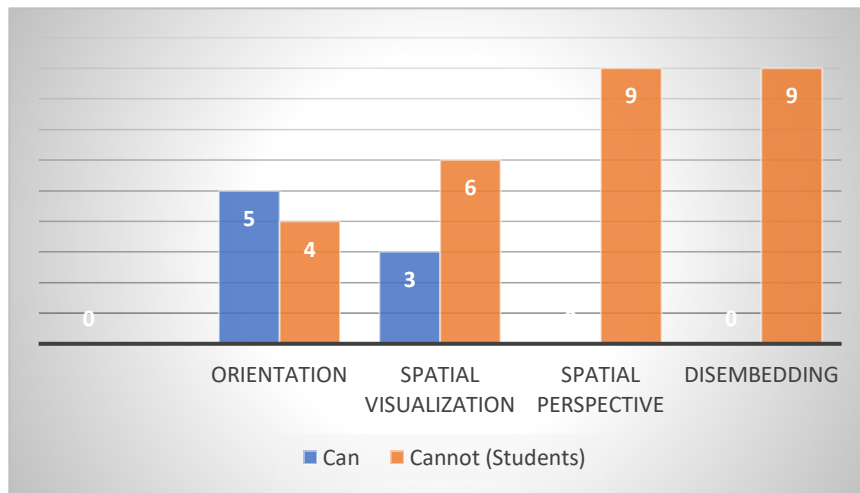
Picture 1. Overview of aspects of high category spatial ability

Table 5 and picture 1 are the data analysis of each aspect of the mathematical spatial ability of students who have high mathematical spatial abilities. Orientation is the ability to identify the shape or position of a geometric object from a certain point of view, from 10 students 8 students can answer properly and correctly while 2 students answer but not correctly. The aspect of spatial visualization is the ability to construct and represent geometric models drawn on a flat plane. For this aspect, out of 10 students, 9 students were able to answer correctly. Spatial perspective is the ability to state the position between elements in the spatial structure at a certain point of view, questions related to this aspect can be answered correctly by 8 students and the last aspect is embedding or the ability to investigate geometric objects, only 7 students are able to answer correctl. These 10 students who have the high spatial ability are able to solve geometric problems properly and precisely.

For students with grades in the moderate category, the following is an analysis of each aspect of mathematical spatial ability.

Table 6. Overview of aspects of middle category spatial ability

Indicator	Can (Students)	Cannot (Students)
Orientation	5	4
Spatial Visualization	3	6
Spatial Perspective	0	9
Disembedding	0	9



Picture 2. Overview of aspects of middle category spatial ability

Table 6 and picture 2 are the data analysis of each aspect of the mathematical spatial ability of students who have moderate mathematical spatial abilities, from 9 students 5 students can answer well and correctly in the orientation aspect while 4 students answer but not correctly. Aspects of spatial visualization there are 3 students able to answer correctly. Spatial perspective is the ability to express the position between elements in a building space from a certain point of view, questions related to this aspect were able to be answered correctly by 0 students and the last aspect, namely embedding or the ability to investigate geometric objects, there were also no students who were able to answer correctly. 9 students who have moderate spatial ability are able to solve geometric problems but there are still errors or not correct. Meanwhile, students who have the low spatial ability do not answer anything for all aspects of mathematical spatial ability. Based on the above analysis, it shows that all subjects with the low spatial ability still have difficulty mastering all indicators of spatial ability. Research relevant to this statement is that researcher Azustiani suggests that students' low spatial abilities in this study have difficulty fulfilling several indicators that the researcher uses [12]. Based on data analysis, it can be found that students who have high spatial ability meet at least 4 aspects of spatial ability, students who have moderate ability meet 2 aspects of spatial ability, but students who have the low spatial ability do not meet all four aspects of spatial ability.

From the data analysis above, it is illustrated that the mathematical spatial ability greatly affects the ability to solve geometric problems [13]. This spatial ability can be formed for students or anyone else by getting used to the concrete learning process into learning, or vice versa, if an

abstract thing will be easily understood by making changes to the real. If these two things alternately can be done to instill and grow spatial abilities, it will give birth to ease in solving various problems in geometry[14]. As this is also expressed in Bruner's theory regarding the stages of the thinking process. Students' Mathematical Spatial Ability Seen From Bruner's Theory (Iconic, and Symbolic stages) in Three Dimensional Materials. Overall spatial ability is seen from Bruner's theory (the iconic stage, and the symbolic stage) on three-dimensional material, namely: a. For subjects with high spatial abilities, students are less able to solve problems using the iconic stage but are able to solve problems using the symbolic stage. b. For subjects with moderate spatial abilities, students are less able to solve problems using the iconic stage but are able to solve problems using the symbolic stage. c. For subjects with low spatial abilities, students are less able to solve problems using the iconic stage and less in solving problems using the symbolic stage.

4 Conclusion

Students with a high level of mathematical spatial ability category can meet all the indicators of spatial ability that researchers use in this study. Students with a category of moderate level of mathematical spatial ability can meet two of the four spatial ability indicators that researchers use. in this study. The Students are who have with the low level of mathematical spatial ability, the category had difficulty fulfilling several indicators of spatial ability that the researchers used in this study.

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