HOTS Problem-Solving Ability and Its Relation to Spatial Ability

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ABSTRACT

The ability to solve HOTS problems is an ability that must be possessed by every student, especially in learning mathematics. However, students' ability to solve HOTS problems is not optimal. This can be seen from the low achievement of Indonesia in the PISA and TIMMS tests. This study aims to determine how the ability of students to solve HOTS problems, especially in geometry material, which is seen from the spatial abilities of each student at SMPN 1 Madapangga. This research is qualitative research, with the research subjects being seventh-grade students of SMP Negeri 1 Madapangga. The selection of research subjects used purposive sampling. The research subjects were selected based on the results of the spatial ability test. The data collection method used in this study was a test. The data in this study were analyzed in 3 stages, namely data reduction, data presentation, and conclusions. The results of this study indicate that students who have low spatial abilities cannot analyze, evaluate, develop, and create. Students with moderate spatial ability can analyze but have not been able to evaluate and create. Students with high spatial ability can analyze and evaluate but have not been able to create.

Keywords: HOTS problem, Flat wake, Spatial ability.

1. INTRODUCTION

The PISA test is one of the factors that influence changes in the curriculum used by Indonesia today [1]. Unfortunately, Indonesia is ranked 74 out of 79 countries in PISA and is ranked fifth from bottom on TIMSS 2015. The low achievement of Indonesian students is caused by various factors, one of which is caused by the lack of students' ability to solve HOTS problems [2]. Several studies say that students' ability to solve mathematical problems caused by HOTS problems is still relatively low [3], [4]. This is caused by various factors such as limited knowledge of teachers regarding HOTS [5], teacher teaching strategies that are not contextual [6], and evaluation instruments that still implement LOTS [7].

HOTS is defined as an ability that stimulates students to analyze, interpret or even manipulate previously obtained information [8]. The ability of students to think at higher levels occurs when students acquire new knowledge, which is then stored in memory for later use in achieving specific goals [9].

This particular goal can be solving a problem that cannot be solved using the usual solution but requires critical, logical, creative, and reflective thinking [10]. Students who have good higher-order thinking skills can distinguish ideas or ideas clearly, argue well, solve problems, construct explanations, hypothesize and understand complex things more clearly [11]. There are three aspects of the cognitive domain, which are presented in Table 1 [12].

In solving HOTS problems, especially in geometry, students' ability to understand mathematical objects is needed, which is called spatial ability [13], [14]. Some research results say that spatial ability is important and can be used in solving mathematical problems experienced by students [15] and is related to students' mathematics learning achievement, especially in geometry and solving more complex problems. Spatial ability generally refers to mental processing and manipulation of spatial information such as shape, location, the relationship between objects, or direction of movement [16]. Spatial ability

Table 1. HOTS cognitive domain

Cognitive Domain	Definition	Indicator
Analyst	Breaking material down into constituent parts and determining the relationship between those parts, and the relationship between those parts, and the overall structure or purpose	Analyst Specifies the elements needed in problem solving Verbs: compare, examine, and test
Evaluation	Make decisions based on criteria and standards. Evaluating includes the cognitive process of examining and criticizing.	Formulate decisions. Verbs: evaluate, judge, refute, decide, choose, support
Creating	Integrate information to form something new or create another and coherent solution. Creating this always involves creative thinking	Create your own ideas and ideas. Verbs: construct, design, create, develop, write,

is divided into five dimensions which are presented in Table 2 [17]**.**

The results of interviews conducted with mathematics teachers at SMPN 1 Madapangga revealed that several teachers had implemented HOTS-based learning. Some teachers were still confused about which questions were classified as HOTS questions and did not understand how to make HOTS questions. This causes teachers to be more inclined to give students questions that are still classified as LOTS questions. The results of the initial tests carried out showed that students' abilities in solving HOTS questions varied. Some students can solve HOTS problems, and some students have not been able to solve HOTS problems.

Reviewing previous research related to HOTS and spatial ability, it can be concluded that research related to solving HOTS associated with spatial ability is still rarely done. Previous studies have discussed HOTS more in terms of initial mathematical abilities, gender, learning styles, and so forth, as well as spatial abilities.

Therefore, researchers consider it necessary to conduct research related to students' ability to solve HOTS problems and its relation to students' spatial abilities as a form of contribution to the literature on solving HOTS problems given to students. The purpose of this study is to find out how the students' ability to solve HOTS problems, especially in geometry material, is seen from the spatial abilities of each student. This research needs to be done. Besides the teacher can find out how the students ability to solve HOTS problems, the teacher can also find out how the spatial abilities of each student. By knowing this, the teacher can reconsider what methods, media, and approaches should be used in each lesson to improve and develop students' HOTS and spatial abilities.

2. METHOD

This research is descriptive qualitative research that aims to provide information on how students' abilities in solving HOTS problems are viewed from students' spatial abilities. The subjects of this study

Table 2. Dimensions of spatial ability

Dimension	Definition
Spatial Perception	The ability to determine the vertical and horizontal directions of an object whose position is confused.
Visualization	The ability to visualize configurations where there is movement or displacement of parts of the configuration.
Mental rotation	The ability to determine the result of a rotation of a 2-dimensional or 3-dimensional image quickly and accurately.
Relation	The ability to recognize the spatial configuration of objects or parts of objects and the relationships between them.
Spatial Orientation	The ability enter to into certain spatial situations.

were 14 students of class VII SMPN 1 Madapangga in the 2019/2020 academic year. However, this article only presented data from three subjects representing students with high, medium, and low spatial abilities. The characteristics of the research subjects are students who have studied the material of flat shapes. The distribution and category of the subject's spatial ability are presented in Table 3.

Table 3. Spatial ability score

Score	Category	Number of students
$s \geq (\bar{x} + DS)$	Hight	2
$(\bar{x} - DS) < s < (\bar{x} + DS)$	Moderate	9
$s \leq (\bar{x} - DS)$	Low	3
Amount		14

Description:

s = student score;

$\bar{x}$ = mean;

DS = standard deviation.

The data in this study were collected using the spatial ability test instrument and the HOTS test. The spatial ability test consists of 20 multiple choice questions that have been validated by one psychologist and one Universitas Ahmad Dahlan (UAD) Mathematics Education lecturer. The HOTS test is a descriptive test validated by one lecturer in mathematics education from UAD and one mathematics teacher from SMPN 1 Madapangga. The advice given on the spatial ability test is to equate the size of the image on the question with the answer choices. While on the HOTS test, the advice given is to replace some terms that are not following the material and need to be presented with contextual images that can support the questions. The HOTS problem is presented in Figure 1.

Susi has a board like in the picture. The board is 3 times its width. The perimeter of the board is 48 cm and it will be cut into several triangles with the same area, so the area of a triangle is 27 cm^2

1. The board will be painted white. If 10 cm^2 of the board consumes $\frac{1}{4}$ cm^3 of paint, then the amount of paint needed to paint the entire surface of the board is...
2. Prove the statement below:
   The area of a triangle is equal to $\frac{1}{4}$ the area of the board?
3. Draw how Susie will cut the board! If Susi wants to rearrange the triangles, what shapes will be formed (draw how the triangles are arranged to form a new flat shape)?

Figure 1 HOTS problem

The data analysis used in this study consisted of three paths, namely (1) data reduction, namely by making an organized summary of all the data obtained

in the HOTS test; examine and review the results of the HOTS problem solving and then make a data transcript consisting of the subject's explanation of the problem given in the written form, and classify them in a broader pattern. (2) Data presentation, namely the data that has been reduced, is presented in various forms of brief descriptions, and finally (3) the conclusion is a series of analyzes that facilitates the flow of analysis that is interrelated with each other from the beginning to the end [18]. The triangulation used is source triangulation, namely checking the data that has been obtained from different sources/informants using the same method to reduce errors during data collection and analysis [19].

3. RESULTS AND DISCUSSION

This section presents data from SA, AM, and F students. SA students represent students with high spatial ability; AM represents students with moderate spatial ability category, and F represents students with low spatial ability category.

The variable data on the ability to solve the HOTS problem was obtained through a test by giving three questions. Based on the data, the ability to solve HOTS questions is obtained as follows:

3.1. Students with Low Spatial Ability

Figures 2 and 3 are student F's answer sheet. It is known that students cannot write the information and questions contained in the problem, analyze by solving information, determine and implement appropriate strategies to solve problems, as shown in Figure 2. This shows that students cannot analyze the information in the problem and do not have strategies and ideas to solve problems. Students who are less able to analyze mathematical problems fail to develop strategies and develop strategic plans, leading to errors in choosing the operations involved and failing to obtain answers [20]. In answer C, it is also seen that students draw a square and a triangle, as shown in Figure 3.

On questions part A and B, students with low spatial abilities cannot write detailed information, analyze information, imagine or construct situations in the questions. This is in line with research which says that students with low spatial abilities are less able to write information that is known and asked completely and to sketch images that are not suitable for the problem [21]. Students with low spatial abilities cannot solve mathematical problems well because they cannot digest the situation in the issue. The subject's inability to make pictures is caused by the

low ability of students to imagine and construct the flat shapes requested in the questions. This difficulty in imagining the form of an object or image causes subjects who have low spatial abilities not to be able to make image illustrations [22]
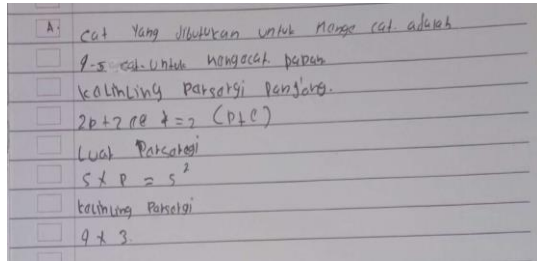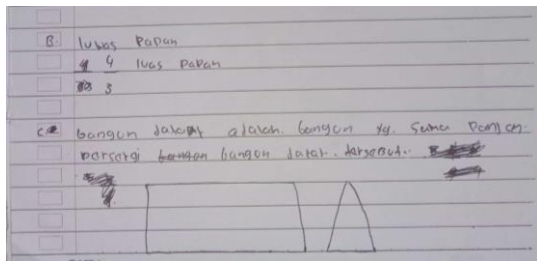

Figure 2 Answer sheet 1 student F

Figure 3 Answer sheet 2 student F

In answer to part C shown in Figure 3, students try to draw a flat shape. However, students ignore the instructions in the problem, so the resulting image is not correct. Students with low spatial ability find it challenging to describe or arrange the situation requested in the problem [22], which causes students to have difficulty answering questions in the first step. Because to make it easier to solve this problem, students must draw the shape of the object before the object is rearranged, determine the direction of the object, and rotate the object so that later a new flat shape will be formed. This is in line with the results of research, which says that spatial ability affects students' ability to solve problems and is directly proportional to the ability to solve geometric problems, improve students' spatial abilities, improve problem-solving skills, and vice versa [23]

3.2. Students with Moderate Spatial Ability

Figures 4 and 5 are AM students' answer sheets. Students write information and questions in questions and can analyze by solving HOTS problems, as shown in Figure 4. In answer to part C, as shown in Figure 5, students draw a square that is cut into seven parts and has not been able to continue to the next stage. This is done by students in order to create new flat shapes by arranging existing triangles.

In parts A and B, students with moderate spatial ability can analyze information and imagine or construct situations in the questions. However, students are less careful in carrying out the analysis and calculations requested in the questions, as shown in Figure 4. Students with spatial abilities moderat were writing down general information and asked incompletely and sketching images that are not following the problem. Students with moderate spatial ability are also able to write down the sequence of steps systematically. However, there are still errors in performing calculations [21], and in terms of conceptualization, they are still unable to determine the concepts that will be used in solving problems [24]. Students who have good spatial abilities provide helpful instructions and perform numerical procedures to calculate the arrangement of squares [25] .
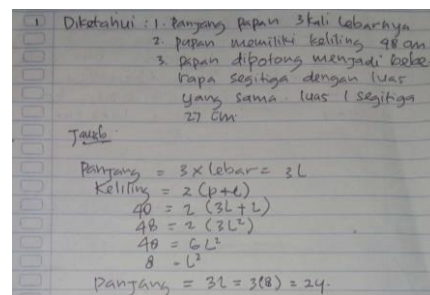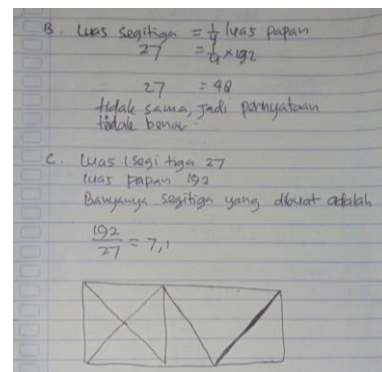

Figure 4 Answer sheet 1 student AM

Figure 5 Answer sheet 2 student AM

In question part C, students have not been able to describe or construct the situation in the question properly due to the students' inaccuracy in processing the information provided, resulting in more triangles than they should. Students have not been able to draw and construct the situation in the problem well. So it can be said that spatial ability is needed in geometry and students' problem-solving skills [23]. Students have not been able to divide the flat shapes referred to in the problem so that in the following step, students cannot arrange the obtained flat shapes into new flat

shapes. Students with high spatial ability can think logistically and significantly influence student problem solving [26], [27]. This causes students with the moderate spatial ability to solve HOTS problems even though the results obtained are incorrect.

3.3. Students with High Spatial Ability

Figures 5 and 6 are SA student answer sheet. It is known that to answer questions parts A, B, and C, students write information and questions in the questions, analyze by solving information, determine and implement strategies to solve HOTS problems, as shown in Figure 6. In part C, students divide the square into four parts, but students have not been able to continue to the next stage, as shown in Figure 7. This can be caused because students have not been able to create ideas in answering question C, so the results obtained by students are not optimal.

Figure 6 Answer sheet 1 student SA

Figure 7 Answer sheet 2 student SA

In the answers to questions A and B, students with high spatial ability can analyze information, imagine or construct situations in the questions. In part C, students have not been able to describe and build the

question's situation correctly. So it can be said that spatial ability is needed in students' geometry and problem-solving skills [23]. Students who have good spatial abilities encourage students to solve problems in mathematics such as calculations [25]. Students with high spatial abilities can solve problems well and have high mathematical abilities compared to moderate and low spatial abilities [28], [29]. Students with high spatial abilities are easier to solve the given HOTS problems. However, students have not been able to divide the flat shapes referred to in the problem, so that in the following step, students cannot arrange the obtained flat shapes into new flat shapes.

4. CONCLUSION

Based on the description above, it is found that spatial ability influences students' ability to solve HOTS problems. Students with low spatial ability cannot solve HOTS problems well. Students with moderate spatial abilities can solve HOTS problems but only achieve analysis indicators. Students with high spatial ability can solve HOTS problems but only reach the hands of analyzing and evaluating.

AUTHORS' CONTRIBUTIONS

All authors contributed to the writing of this paper. All authors read and approved the final manuscript.

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