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Submission date: 20-Apr-2023 01:28AM (UTC-0500)
Submission ID: 2070104950
File name: C12_ANALYSIS OF STUDENTS'SPATIAL.pdf (285.34K)
Word count: 3892
Character count: 21057

J. Pijar MIPA, Vol. 18 No. 1, January 2023: 36-41 ISSN 1907-1744 (Cetak)
DOI: 10.29303/jpm.v18i1.3186 ISSN 2460-1500 (Online)

ANALYSIS OF STUDENTS' SPATIAL ABILITY IN SOLVING PROBLEMS OF FLAT SIDE SPACE SUBJECTS BASED ON VAN HIELE'S LEVEL OF THINKING

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Received: December 4, 2021. Accepted: May 11, 2022. Published: January 30, 2023

Abstract: This study aims to describe students' spatial abilities in solving geometrical problems of flat-sided shapes based on van Hiele's level of thinking in grade eight junior high school of SMP Negeri 1 Aikmel in the academic year 2020/2021. This type of research is descriptive qualitative. The research subjects were taken by purposive sampling, namely nine students of class VIII consisting of 3 students, each with van Hiele thinking level 0 (visualization), level 1 (analysis), and level 2 (abstraction). Subjects were selected based on having received material on plane shapes and had taken the van Hiele geometry test. Data collection techniques were van Hiele's geometry ability test, spatial ability test, and interviews. Data validity uses Aiken and triangulation methods. The results of this study indicate that: (1) subjects with level 2 (abstraction) have spatial abilities consisting of visualization, spatial orientation, and spatial rotation. (2) subjects with level 1 (analysis) have spatial abilities consisting of spatial orientation. (3) subjects with level 0 (visualization) do not have spatial abilities.

Keywords: *Spatial Ability, van Hiele Geometry Ability, Flat Side Spatial Geometry*.

INTRODUCTION

Geometry is a material that is close to everyday life. Geometric shapes can always be associated with everyday objects. Geometry is essential in human life, from the human need to determine the amount, measuring numbers, soil and earth, and making maps [1]. Geometry also helps develop good reasoning and can be applied to solving problems in everyday life. However, readiness to learn geometry must still be considered more challenging to understand. The 2015 TIMSS (Trends In International Mathematics And Science Study) survey found that Indonesian students were categorized as low in achieving geometry results. The percentage of Indonesian students who can answer correctly for geometry questions is 20% lower than the international average, and other measured mathematical material abilities, such as number problems 30% and algebra questions 30% [2].

Learning geometry takes an ability to represent an abstract concept in a two/three-dimensional visual form and make changes to a geometric shape called spatial ability. Students with high spatial abilities will find it easy to understand geometric problems because they can also detect relationships and changes in geometric shapes. The statement shows a positive relationship between spatial ability and the ability to solve geometric problems. If educators want to improve students' geometric thinking levels, they must first know and understand the spatial abilities of these students [3].

However, in reality, the students' spatial abilities are still weak. It is because many students still need geometry problems in visualization for problem-solving, and in general, students need help constructing geometric shapes. Therefore it must be a concern because geometric and spatial shapes have been introduced to children from an early age. [4]. The fact that many students have difficulty in solving geometry, especially the material on the flat side. One effort to find out students to understand geometry is by using van Hiele's theory of thought to overcome learning difficulties in solving geometry, especially the material of flat side shapes [5].

Based on the results of an interview with one of the mathematics teachers of SMP Negeri 1 Aikmel class VIII, many students still need help solving geometrical problems of flat-sided shapes, especially understanding the combination of flat-sided shapes and elements of flat-sided shapes. In addition, students also tend not to be able to mention reasons when answering questions. When given the material, students answered that they understood, but when given a question, they only answered carelessly and needed help explaining the answer. For example, when students are faced with the problem of combining several flat shapes, students tend to need help identifying the type of flat shapes. In real-life geometry applications, students also still need help. Students' imagination and ability to express questions in the form of pictures are still low.

One of the theories related to learning geometry is van Hiele's theory. The levels of thinking in van Hiele's theory are sequential and hierarchical. For students to play well at an advanced level in van Hiele's hierarchy, they must master most of them from lower to higher

ISSN 1907-1744 (Cetak)
ISSN 2460-1500 (Online)

levels. By solving geometry problems using van Hiele's theory, students' spatial ability is needed to describe and digest a problem to find an accurate final answer. Flat Based on Van Hiele's Level of Thinking for Class VIII of SMP Negeri 1 Aikmel for the 2020/2021 Academic Year".

RESEARCH METHODS

The type of research used is qualitative research with a descriptive approach, namely to describe the spatial abilities of class VIII SMP Negeri 1 Aikmel students in learning the geometry of flat-sided shapes based on van Hiele's level of thinking. This research was given to class VIII SMP Negeri 1 Aikmel, with as many as 95 people. The research subjects in this study amounted to nine people, with each student representing van Hiele's level of thinking from level 0 to level 2, where this subject was taken after students took the van Hiele geometry test. Data collection techniques in this study used tests, interviews, and documentation. The research instrument used in this study was a test of van Hiele's geometric thinking ability, a test of spatial ability, and an interview guide. Van Hiele's thinking ability test was used to determine the research subject, namely thinking level 0 (visualization), level 1 (analysis), and level 2 (abstraction). Then the research subjects were given a spatial ability test and interviewed.

Data analysis techniques include data reduction, data presentation, and conclusion drawing. The results of the data analysis are then presented in the form of a descriptive description. The data from the results of the tests and interviews were then described and analyzed to determine the students' spatial ability in solving geometrical problems of flat-sided geometry based on van Hiele's level of thinking. Data analysis techniques include data reduction, data presentation, and conclusion drawing. The results of the data analysis are then presented in the form of a descriptive description. The data from the results of the tests and interviews were then described and analyzed to determine the students' spatial ability in solving geometrical problems of flat-sided geometry based on van Hiele's level of thinking. Data analysis techniques include data reduction, data presentation, and conclusion drawing. The results of the data analysis are then presented in the form of a descriptive description. The data from the results of the tests and interviews were then described and analyzed to determine the students' spatial ability in solving geometrical problems of flat-sided geometry based on van Hiele's level of thinking.

As for testing the spatial ability test of students, the characteristics of spatial ability according to Yilmaz [6] are used; some of the indicators used can be seen in Table 1.

Table 1. Spatial Ability Test Indicators

No.	Characteristics of Spatial Ability	Indicator
1.	Spatial Visualization	Changing an object into a different shape
		Determine the form of change of a three-dimensional object into two dimensions
2.	Spatial Orientation	Determine the shape of an object when viewed from different directions
3.	Spatial Relations	Determine the relationship of an object with other objects
		Determine the position of an object

RESULTS AND DISCUSSION

Based on the results of the Van Hiele thinking ability test, nine students were taken as subjects from level 0 to level 2 to be tested for their respective spatial ability tests. The results of the analysis of test and interview data on van Hiele's thinking level subjects at level 0 only met some of the indicators of the characteristics of spatial ability. Subjects with level 1 only completed the characteristics of spatial ability in spatial orientation, and level 2 subjects met all indicators of the characteristics of spatial ability in spatial visualization and orientation and spatial relations. The following shows the results of the spatial ability test of students from each van Hiele level, representing.

Spatial Ability Test and Interview Results at Level 0 (Visualization)

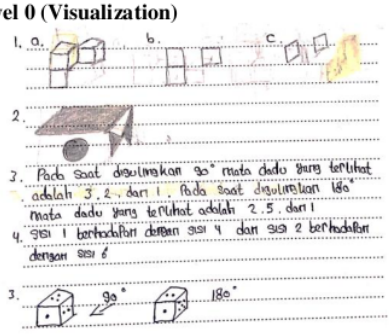

Figure 1. Test ResultsSpatial Ability At Level 0

Based on the test results in Figure 1, the subject still needs to meet the characteristics of spatial ability on indicators of spatial visualization, spatial orientation, and spatial relations. In the characteristics of spatial visualization, the subject can still not change an

object into a different form and determine the form of change of a three-dimensional object to two dimensions. It can be seen from the results of the subject in questions number (1.a) and 2. In question number (1.a), the subject needs help understanding the examples in the problem and imagining the meaning of the question. It takes a lot of work to answer the question. While in question number 2, the subject has yet to describe the grid of blocks correctly. During the interview, the subject stated that it was difficult to understand and imagine the problem.

On the characteristics of spatial orientation, it was found that the subject could not understand the change in the object's shape when viewed from a different direction. It is seen from different directions. While the results of the interview showed the subject stated that the question could be said to be easy, this can be seen from the examples in the problem then the position of the cube arrangement was drawn according to the direction requested. However, the subject still needed to be corrected in answering the question.

In the characteristics of spatial relations, the subject is still unable to determine the position of an object and the relationship of an object to other objects. It can be seen from the results of the subject's test on questions number 3 and 4. In question number 3, the subject has yet to determine the position of the dice if it is rolled 90 degrees. Right and 180 degrees forward. This is because it is difficult to imagine the dice. In question number 4, the subject has yet to be able to determine the relationship between the sides on the beam and needs help understanding the question's meaning. While the results of the interview stated that question number 3 was difficult and only imagined the position of the dice. Question number 4 was fairly easy to solve by looking at the numbers on the sides of the block, but the subject still needed to answer the questions correctly.

Spatial Ability Test and Interview Results at Level 1 (Analysis)

Figure 2 shows the subject only meets the characteristics of spatial ability on the spatial orientation indicator. On the characteristics of spatial visualization, the subject is still unable to change an object into a different form. It can determine the change in the shape of the object from three dimensions to two dimensions. It can be seen from the results of the subject's test in questions number (1.a) and 2. number (1.a). The subject has yet to determine the arrangement of the cubes and cannot understand the images in the sample questions, so it is difficult to draw the correct arrangement. Meanwhile, the subject stated that the student had never worked and had difficulty imagining the picture of the arrangement of the cubes. While in question number 2, the subject was correct in describing the grid of blocks.

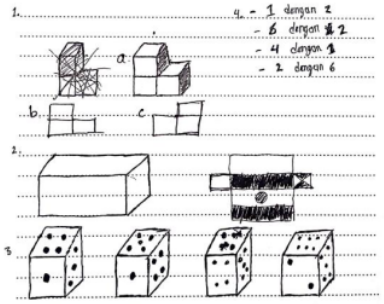

Figure 2. Test ResultsSpatial Ability At Level 1

In the characteristics of spatial orientation, the subject can understand the change in the shape of an object when viewed from a different direction. In the interview results, the subject stated that the question could be easy. IT could be seen from the examples in the problem, then the position of the cube arrangement was drawn following the requested direction.

In the characteristics of spatial relations, the subject is less able to determine the position of an object and the relationship. It can be seen from the results of the subject's test on questions number 3 and 4. In question number 3, the subject can answer the position of the dice when it is rolled 90 degrees, but when it is rolled 180 degrees, it still needs to be quite right. In the interview results, the subject also stated that the question was easy and did it by understanding it and imagining if it was rotated 90 degrees to the right and 180 degrees forward. While in question number 4, the subject can still not determine the relationship between one side of the beam and the other. It can also be seen from the interview results that the subject needs clarification and needs help understanding and working on the problem.

Spatial Ability Test and Interview Results at Level 2 (Abstraction)

Based on the test results in Figure 3, the subject has optimally met spatial ability characteristics on spatial visualization, spatial orientation, and spatial relations indicators. In the characteristics of spatial visualization, the subject has been able to change an object into a different shape and change the object from three dimensions to two dimensions. During the interview, the subject stated that the question had been worked on and then described. In question number 2, the subject made a grid of blocks correctly.

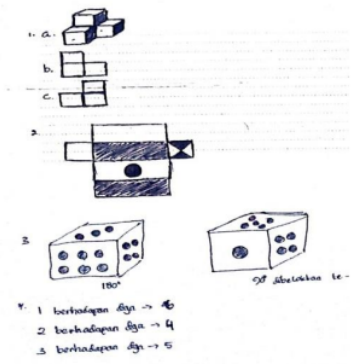

Figure 3. Test ResultsSpatial Ability At Level 2

On the characteristics of spatial orientation, the subject can understand the change in the shape of an object when viewed from a different direction. Correct in drawing unit cubes when viewed from behind or from the right. During the interview results, the subject stated that the question was easy and the way to do it was by seeing and understanding the picture of the example of the arrangement of the cubes in the question, then drawing the arrangement according to the question asked.

On the characteristics of spatial relations, the subject is correct in determining an object's position and the relationship between one object and another. It can be seen from the subject's test answers to questions 3 and 4. If it is rolled 90 degrees, then it is rolled 180 degrees. During the results of the interview, the subject was able to understand and work on the problem so that they could imagine and describe the number of the dice when rolled 90 degrees to the right and 180 degrees forward correctly. While the interview results, the subject stated that the question was difficult and the method did it by understanding the problem first. Then imagine the dice if rolled 90 degrees to the right, then the dice number that appears is described. It is rolled 180 degrees then the dice number that appears is also described. In question number 4, the subject was able to determine the relationship between the sides of one beam with the other side of the beam. It was also seen from the results of the interview. Question number 4 it was understood the sides on each beam were then drawn and imagined the opposite sides of the four blocks.

The conclusions of the results of the analysis of tests and interviews' spatial abilities are presented in Table 2.

Table 2. Results of Analysis of Students' Spatial Ability Tests and Interviews

Van Hiele's Level of Thinking	Subject Name	Characteristics of Spatial Ability		
		Spatial Visualization	Spatial Orientation	Spatial Relations
Level 0 (Visualization)	SV1	Does not meet the indicators	Does not meet the indicators	Does not meet the indicators
	SV2	Does not meet the indicators	Does not meet the indicators	Does not meet the indicators
	SV3	Does not meet the indicators	Does not meet the indicators	Does not meet the indicators
Level 1 (Analysis)	SA4	Meets one indicator	Already meet the indicators	Meets one indicator
	SA5	Meets one indicator	Already meet the indicators	Meets one indicator
	SA6	Meets one indicator	Already meet the indicators	Does not meet the indicators
Level 2 (Abstraction)	SAb7	Meets one indicator	Already meet the indicators	Already meet the indicators
	SAb8	Already meet the indicators	Already meet the indicators	Already meet the indicators
	SAb9	Already meet the indicators	Already meet the indicators	Already meet the indicators

The description of students' spatial abilities on the matter of flat-sided wake-up material based on van Hiele's level of thinking is as follows:

Subjects with Spatial Ability At Level 0 (Visualization)

Spatial ability at level 0 (visualization) SV1, SV2, and SV3 only meets some indicators

of kaAt level 0 (visualization). The subject also needs help understanding the problem well. It is due to the low spatial ability it has. Students with low spatial ability will need help seeing the shape of objects from different perspectives [9].

Subjects with Spatial Ability At Level 1 (Analysis)

It is in line with research conducted by Armstrong that the subject has been able to transform the imagined object so that it can draw objects seen from different directions. It can be seen from the spatial ability that meets the spatial orientation [11]. Subjects are also able to make images with different positions. Subjects at level 1 (analysis) can change the position of the arrangement of shapes and change the position of the shapes correctly.

Subjects with Spatial Ability At Level 2 (Abstraction)

The spatial abilities of SAb7, SAb8, and SAb9 already meet the characteristics of optimal spatial visualization, spatial orientation, and spatial relations. However, in SAb7, the spatial visualization characteristics could be more optimal because they only meet one indicator. In this case, the subject of ability at level 2 (Abstraction), there are already subjects who meet all the indicators on spatial visualization, spatial orientation, and optimal spatial relations. In this case, the subject has met high spatial ability. It is in line with several studies which state that the ability spatial ability of students who have high mathematical ability has fulfilled all indicators of spatial ability [12]. Students who reach level 2 (abstraction) van Hiele can already correctly solve geometric problems using spatial reasoning abilities to build geometric structures in an axiomatic system to solve given issues [13-16]. Research conducted by Alex, K. Jogmol regarding the analysis of geometric attitudes based on the characteristics of van Hiele in Africa states that the optimal spatial ability of a student is needed by the student in learning mathematics, especially in learning geometry [17-20].

CONCLUSION

The results of this study are already level 2 (abstraction) students who meet all indicators of spatial ability characteristics, namely spatial visualization, spatial orientation, and spatial relations. Indicators capable of changing an object into a different form, able to determine the shape of an object's change from three dimensions to two dimensions, able to determine the shape of an object when viewed from different directions, able to rotate the position of an object and able to determine the relationship between one object and another. Students of level 1 (Analysis) only meet the characteristic indicators of spatial ability in spatial orientation with indicators able to determine the shape of an object when viewed from different directions. Students of level 0 (Visualization) have not been able to meet all the characteristics of spatial ability indicators,

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