International Journal of Current Science Research and Review
ISSN: 2581-8341
Volume 07 Issue 07 July 2024
DOI: 10.47191/ijcsrr/V7-i7-02, Impact Factor: 7.943
IJCSRR @ 2024
www.ijcsrr.org

Spatial Ability of Students in Solving Unit Cube Problem

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ABSTRACT: This study aims to expose the ability of high school students in solving field problems three. The intended third field is the cube. This article uses a qualitative approach with in-depth interviews was conducted for 4 weeks. Data collection techniques in this study consisted of observation, interviews, tests and documentation. The interview guidelines and test in the form of planes three which aim to determine visual spatial abilities have been validated by 2 experts in the fields of mathematics and mathematics education. The research subjects were 11th grade students majoring in Science at SMAN 3 Blitar who had taken subject matter in Planes three. Based on the analysis, it can be concluded that in solving the cube problem in accordance with the spatial abilities of the subject there are several stages: the observation of the image, imagining, relating to the term from other concepts and solving the problem.

KEYWORDS: Cube, Plane three, Spatial ability.

INTRODUCTION

The most useful thing about visualization in mathematics is to allow the very abstract into something less abstract or concrete. This is especially important for students who have difficulty in understanding something abstract. Spatial thinking is concerned with the location of objects, shapes, relationships with each other and ways or paths taken when walking [1]. The formation of geometric shapes in space two or Plane three mentally and see from different angles, spatial visualization is the most important part in geometric thinking [2]. Geometry and spatial sense are the basic components of mathematics learning [3]. Learning geometry can help students develop some skills including imaginary visuals, conjectures, deductive reasoning, logical arguments and evidence [4]. Battista (1990) [5] reported that spatial visualization and logical reasoning are significantly related to geometric and geometric achievements of problem solving. Saad & Davis (1997) [6] reported that language skills, in addition to spatial abilities, also predicted geometric performance. Zoelandari [7] says spatial visual intelligence is the ability to understand, process and think in visual form. The child with this skill is able to translate the image form in his mind into a two or three dimensional or plane.

Children who have visual intelligence can be able to solve the problem of space (spatial) [8]. The child is able to observe the spatial world accurately, even imagining geometric and three-dimensional shapes, and the ability to visualize with graphs or spatial ideas. Measuring the level of spatial visual intelligence can be done in two ways. The first can be measured by self-assessment quizzes to the condition of visual abilities and habits and both can be measured by their ability to solve space-related problems [9]. Meanwhile, according to [10] there are four ways to improve spatial thinking ability: (1) practice or spatial exercise, (2) using symbolic statements, (3) analogical thinking, and (4) doing movements.

This study involves students' visual abilities. There are some opinions from previous research on the importance of having spatial abilities. [11] says that in industrial technology the results of spatial learning are very useful in the application of multimedia and modeling. [12] also supports by stating that almost all topics in machine drawing are in desperate need of good spatial learning outcomes. [13] argues that the results of spatial learning can be applied in the science of astronomy, education, geography, geoscience and psychology. Likewise, [14] says the importance of studying the spatial part in engineering and mathematics, especially in geometry.

[15] mentions five categories of spatial abilities as mental rotation, spatial perception, spatial orientation, spatial relationships and spatial visualization. Considers mental rotation as a sub-component of spatial visualization while [16] and [15] regard as a separate component of spatial ability. [17] also states that the ability of space has two basic components of spatial relations and spatial visualization. Spatial relationships involve skills to understand the 2-D and 3-D rotation of the form. Mental rotation is sometimes called spatial relations [18]. Mental rotation involves cognitive processes to mentally rotate two or three-dimensional objects quickly and accurately [16]. Mental rotation and spatial visualization are the two most common categories agreed in the literature. Spatial ability is closely related to the teaching of many subjects of mathematics and geometry [19][20]. In addition, spatial ability is also

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associated with mathematical problem solving [17][21][22]. From this perspective, [3] emphasizes the importance of spatial abilities in mathematics education and notes that spatial abilities are important and include 2D and 3D objects' mental representation and manipulation with perceptions of various object perspectives.

This research focuses on describing students' spatial abilities in solving unit cube problems for high school students. This needs to be done because spatial abilities are really needed in solving geometric problems. The students' ability to solve geometric problems is very low. This statement is supported by [23] who emphasize that many students experience difficulties in learning geometry.

Similar research that has been carried out is [24] who attempted to diagnose the visual spatial climbing abilities of Kuningan University students on the problem of distance from points and lines as well as distance between points and planes. Next are [25] who attempt to determine students' visual spatial abilities in calculus courses and [26] who discuss the relationship between spatial intelligence and mathematics learning outcomes in spatial construction material for 5th grade elementary school students.

METHOD

The research was conducted for four weeks, namely mid-January to mid-February. The research was carried out at SMA 3 Blitar. The research subjects were grade 11 students majoring in science. Data collection techniques used in this study are as follows:

2.1 Observation

Observations conducted by researchers to determine whether the students who made the candidate subject has taken the material field three or not. Researchers are looking for students who have taken the material field three, so that interviews done can run well.

2.2 Interview

The interview was conducted by question and answer directly to the research subject. Interviews in this study were conducted to find out more in depth about the spatial visual abilities of students in solving field problems three. By interview, it is expected to know the extent of students' spatial visual ability.

2.3 Test

By giving tests to students to determine students' understanding of the questions given. Below are the questions given to the subject adapted from the test by [27]. The difference is research conducted by [27] to evaluate sixth grade students in Turkey regarding spatial visualization abilities and to determine students' strategies and errors made when solving problems that require spatial reasoning. Meanwhile, this research aims to find out more about how students solve field problems. It could be said, how students' procedures in solving three-plane problems are in accordance with their visual spatial abilities.

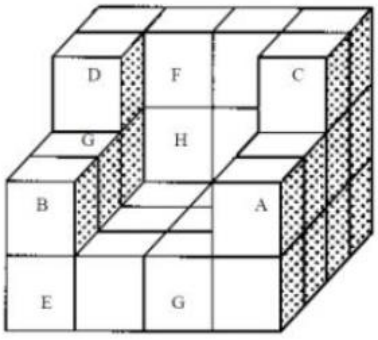

Figure 1. Model the given problem

Notice waking up above, then answer the following questions: (a) how many unit cubes on the wake up? (b) how many unit cubes have four faces? (c) how many unit cubes have no face? (d) Draw the wake up from the left side!

2.4 Documentation

Documentation is used to reinforce data obtained from observations, interviews and tests. Documentation is done to view the records or archives done in the research. These documents include, in the form of, the results of observation, the results of student work that can provide data information, test results. In addition documents are used to provide a visual overview of student activities.

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RESULTS AND DISCUSSIONS

Following are the respondents' answers regarding the problems that have been given.

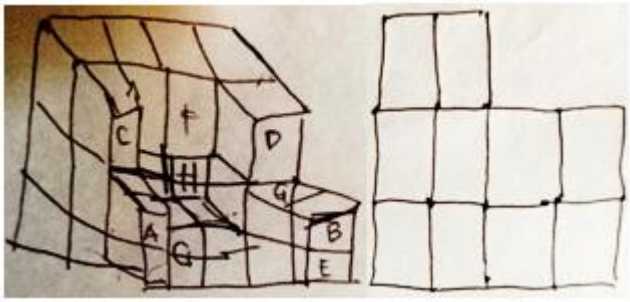

Figure 2. Respondents' answers to the problems given

From these answers it can be seen that the respondents had difficulty in describing the requested shape. It was found that the ability to imagine an object to be rotated was less precise. Respondents considered the left side requested to be the right side of the object.

The following is an interview with one of the subjects to find out the reasons for giving answers regarding the problems given.

O: good afternoon mbak, have been reading the problem.....
S: good afternoon...
O: there is a pile of unit cubes, according to mbak how many cubes of units in the pile?
S: I think there are 30.
O: that's from where 30?
S: this I count this for my two, it runs out right I count first
O: why divided by two?
S: same,
O: the same thing?
S: the right and left are the same
O: oooo same yes.....same, that's what it's called
S: symmetrical
O: oooo, right left symmetrical, how many Mbak cube?
S: 30.

Section to answer (b)
O: if many cubes of units that have 4 faces how many?
S: There are 4
O: there is 4 ,,,,, how to calculate it?
S: As before, because of symmetry, I count the right first I multiply the two

Interview to answer section (c)
O: o yes that .... if the unit cube that has no face how many?
S: there is no
O: Why there is no
S: because all have advance, at least all have two faces.
O: means C's answer does not exist?
S: yes

Interview for section (d)
O: if part d, describe wake up from the left side ..... how is that picture?
S: this my image is aligned to the right

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O: try again, do it?
n the minutes to 02:59 while answering begins to illustrate again the correct answer.
S: this is facing right?
O: the term geometry does?
S: not rotation, but reversed
O: reversed or rotated?
S: shifted
O: the term geometry? If rotation rotation if what is shifted?
Transss.....
S: translation
The minute 03.47 has finished drawing.
O: yes right, see it from the left ..... the bottom of it there are 4 stacks there are 3, so yes, it's from left or from right?
S: from left
O: thank you for your time
S: yes....

From these interviews obtained data that subjects experiencing confusion in imagining an object, it is seen from the answer who states the right side, but the question wants from the left side. In this case it is only a matter of perception only, that the left assumption of the subject is the right part of the subject. In solving the subject problem using a strategy using a pattern of symmetry and linking with other geometric concepts (rotation, translation).

This confusion is natural, because [23] have explained that students experience difficulties in solving geometric problems. Apart from that, [28] added that geometry learning outcomes for high school students have decreased. This is detailed by students' low knowledge of geometry and low students' reasoning abilities in geometry material. Thus, it is necessary to provide a systematic and procedural flow description or drawing, so that high school students are able to solve geometric problems, especially unit cube problems.

Based on the results of observations made by researchers, the following presented the subject line in solving the problem of cubes based on the ability of spatial owned.

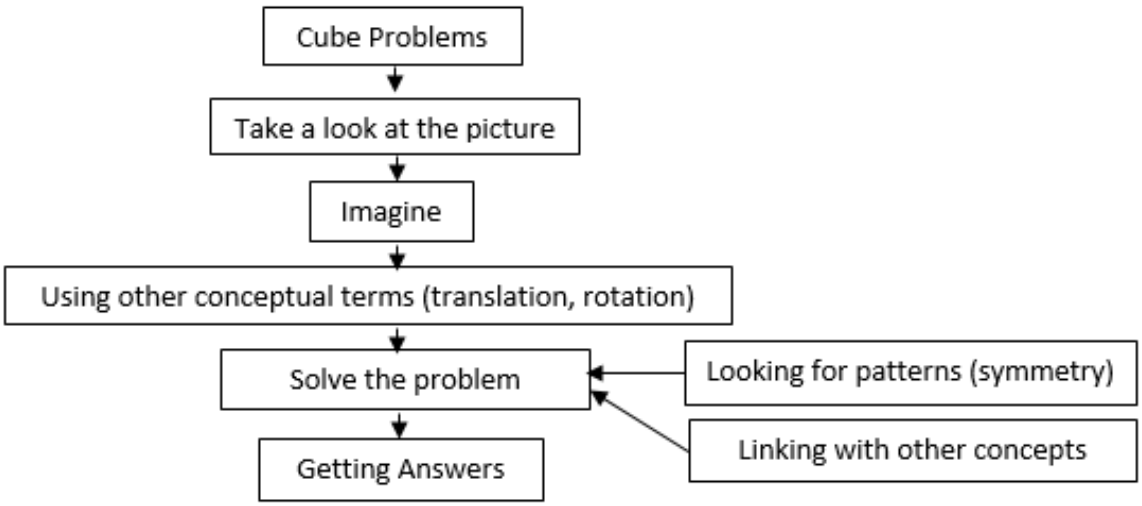

Figure 3. The Spatial Ability Of The Subject In Solving The Cube Problem

Figure 3 shows the flow of spatial abilities of high school students in solving cube problems. The steps contained in each plot are the approach or method of high school students in describing unit cube problems so that they are finally able to answer or solve the problem. This approach is in accordance with what was conveyed by [29] who explained that high school students must have mastery

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of geometry material which is carried out in stages, so that in the future it is possible to solve geometric problems and connect the interpretation of geometry to other contexts.

CONCLUSIONS

In solving the cube problem according to the subject's spatial abilities, there are several stages that are followed, namely: observing the image, imagining, relating it to terms from other concepts and solving the problem. In solving problems, subjects use a strategy, namely looking for patterns that appear in cube shapes with the help of symmetrical properties and linking them with other concepts. In the flow of solving problems, the subject is good at working on the problems given with his spatial abilities. It's just a difference in perception between the right and left sides. The subject assumes that the left side is part of the right side. It is best to make some sort of agreement on this matter. The suggestion for future research is to investigate spatial abilities in areas other than cubes.

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