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GENDER SPECIFIC STUDY OF STUDENTS' SPATIAL INFERENCE IN SOLVING GEOMETRI PROBLEM

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Abstrak

Pemikiran spasial sangat penting untuk akuisisi dan konstruksi. Pemikiran spasial dapat membantu siswa memahami konsep geometris. Siswa mulai memahami konsep geometri pada tahap prilaku. Pemikiran spasial siswa pada tahap perilaku konkret tidak sedikit mampu melakukan eksplorasi. Penelitian ini mengkaji kemampuan siswa menggunakan penalaran spasial untuk menyelesaikan masalah geometri berbasis gender. Jenis penelitian ini adalah deskriptif kualitatif. Melalui lembar kerja, siswa mampu melakukan penalaran spasial. Selain lembar kerja, pengumpulan data pendukung diperoleh melalui wawancara mendalam. Tes dan wawancara digunakan untuk mengumpulkan data. Sampel yang menjadi target pada penelitian ini adalah siswa sekolah dasar kelas lima, responden pria dan wanita. Hasil penelitian menunjukkan bahwa siswa laki-laki memiliki keunggulan penalaran dibandingkan siswa perempuan, khususnya dalam visualisasi spasial. Setiap individu memiliki perkembangan kognitif yang berbeda,tergantung cara beradaptasi terhadap lingkungan, dan interaksi social.

Kata kunci: Gender, Spasial, Penalaran, Geometri, Masalah

Abstract

Spatial thinking is essential for acquisition and construction. Spatial thinking can help students understand geometric concepts. Students begin to understand geometric concepts at the behavioral stage. Students' spatial thinking at the scene of concrete behavior needs to be more able to explore. This study examines students' ability to use spatial reasoning to solve gender-based geometry problems. This type of research is descriptive qualitative. Through worksheets, students can do spatial reasoning. In addition to the worksheets, supporting data was collected through in-depth interviews. Tests and interviews were used to collect data. The target sample in this study were fifth-grade elementary school students, male and female respondents. The results showed that male students had reasoning advantages over female students, especially in spatial visualization. Each individual has a different cognitive development, depending on how to adapt to the environment and social interactions.

Keywords: *Gender, Spatial, Reasoning, Geometry, Problem*

Introduction

Since geometry is a subset of mathematics, it has an abstract subject of study and relies on spatial reasoning to resolve issues (Lamb, 2010; Nuraida, 2019). Additionally, the development of spatial reasoning is necessary to ensure that pupils fully comprehend a geometric notion (Chamberlin, 2005; Fuchs, 2009). Right now, learning still doesn't place a lot of emphasis on spatial reasoning.

What is meant by spatial reasoning is reasoning that involves objects with spatial components such as mental rotation, spatial orientation, and spatial visualization (Kaisari & Patronis, 2010; Mashami & Gunawan, 2018). Other experts state that spatial reasoning is an activity to perceive, store, create, and communicate objects in three-dimensional space to conclude from the information provided (Engle & Conant, 2002). Spatial reasoning is part of mental abilities in the mathematical thinking process.

What is meant by the spatial component of mental rotation is a cognitive process in which students imagine how 2D and 3D objects will appear after being rotated. The mental rotation includes the ability to turn a shape appropriately (Warner & Kaur, 2017). Mental rotation can also be a rotary transformation of a visual stimulus that allows it to be presented in a new orientation. Spatial orientation is an ability related to navigation or orientation in unfamiliar surroundings (Maskur et al., 2020). Spatial orientation is the idea of perspective taking or the skill of imagining how an object or scene looks from a different perspective to the observer.

In the spatial orientation task, students are asked to determine the object's position by mental or physical self-positioning. Meanwhile, spatial visualization is the skill of manipulating or changing the image of spatial patterns to other visual settings. Spatial visualization is the ability to imagine or provide an overview of a spatial form whose parts have changed (Gilsing & Nooteboom, 2006; Wartono et al., 2018).

Maier (Ridwan et al., 2017) state five components of spatial reasoning, namely: (1) spatial perception; (2) spatial visualization; (3) mental rotations; (4) spatial relations; and (5) spatial orientation. Spatial perception is the ability to be aware of one's relationship with the environment (exteroceptive process) and with oneself (whole-petive process). Visual perception is limited by action (Hadinugrahaningsih et al., 2017). According to Egenhofer & Franzosa, spatial relations are grouped into three categories: topological relationships, directional relationships, and distance relationships (Pisano, 2015). Spatial relations result from representing spatial information using high-level concepts before concluding the existence of spatial relations in question (Berpikir et al., 2017). Spatial orientation refers to a person's ability to adjust his orientation or posture to the surrounding environment.

In this study, spatial reasoning involves three components: mental rotation, spatial orientation, and spatial visualization. Mental rotation is the ability of students to rotate geometric shapes correctly, and spatial visualization is the ability to provide an overview of a spatial form whose parts have changed. Spatial orientation determines the visible condition of an object when viewed from various directions.

According to this explanation, spatial reasoning is essential for comprehending geometry. At the ESM level, however, more research on spatial reasoning still needs to be done. Children's understanding of geometry starts (Kane et al., 2016; Surya & Syahputra, 2017). Meanwhile, mathematics includes geometry. Some scholars claim that mathematics is an official deductive axiomatic system (Bagni, 2004; Khoiriyah & Husamah, 2018). As an axiomatic system, mathematics includes elements, compositional rules, or quality criteria that can create functional relationships between members (Saputra et al., 2019; Sullivan et al., 2009). As a result, a person's success in mathematics is greatly determined by how well he understands the subject. Additionally, elementary schools already cover geometry.

This research was conducted at ESM before the researchers conducted a preliminary study on the students' spatial reasoning abilities. It was found that 17.8% of students had high spatial reasoning, 57% had moderate spatial reasoning, and 25.2% had low spatial reasoning.

According to Piaget, students of ESM, or elementary school children, enter the concrete operational stage, where this concrete operation starts from the age of (6 years to 12 years). The child is mature enough to use logical thinking or processes at this stage, but only for current physical objects. Without a physical thing in front of them, children at the concrete operational stage still experience great difficulties (Harris et al., 2009; Nelson et al., 2018).

The researcher will therefore evaluate primary school students according to gender. Because there are clear disparities between men and women in their capacities for spatial reasoning, researchers focused on men and women (Brown, 2010; Etemadzadeh et al., 2013; Shriki, 2010). Therefore, the purpose of this study is to investigate how students use spatial reasoning to solve gender-based geometry issues.

Method

The researcher used a qualitative research approach with a descriptive type of research. The research was conducted at the ESM and was carried out for approximately two weeks. Respondents of class 5 students were 28 from elementary school muhammadiyah (ESM) Parepare, South Sulawesi, Indonesia. Furthermore, men and women were taken from the respondents because the research subjects were selected with the controlling variable of equal mathematical ability and could communicate what the matter thought. Supporting instruments are tests and interview guidelines. There are three geometry questions: the first question for the spatial rotation indicator, the second question for the spatial visual indicator, and the third question for the spatial orientation indicator.

Data collection techniques that have been carried out are as follows. The data collection techniques used tests and interviews, where research subjects were given questions about spatial reasoning. When the research subject is working on spatial reasoning questions, the researcher is interviewing the research subject. The interviews conducted in this study were semi-structured. The interview guide is only a reference or an outline of the questions asked, and questions can develop according to the situation at the time of research. Time triangulation was performed. The first data from the research subject was compared with the second data from the research subject. If the triangulation results show that the first stage of information is consistent, credible data is obtained, and the first data is analyzed further to answer research questions.

Activities for qualitative data analysis are interactive and ongoing to ensure that the data is constant or saturated (Aini, Juniati, & Siswono, 2020). Three steps make up the analysis activity in this study: data reduction, data display, and conclusion making.

Results and Discussion

There were 10 men and 18 women among the 28 respondents from class V. Male students were given the interview code SLK, while female students were given the code SP. SLK and

SP can communicate their work well, have the same level of mathematical proficiency, and have access to the Building Space content.

Female Students' Spatial Reasoning in Solving Geometry Problems

The first, mental actions were taken by the subject, reading the problem slowly and then identifying important information from the situation, such as cube ABCD. EFGH rotated 2700, then looked for the location of the corner points after being spun. To find the place of the corner points of the research subjects, they did not use visual aids but described the process of turning in the problem to represent the rotation of one of the corner points, namely corner A. The method used by the subject was to rotate the corner point by 900 as much as three times for 900 times. Three, the result is 2700. This is shown in doing the SP and the interview results.

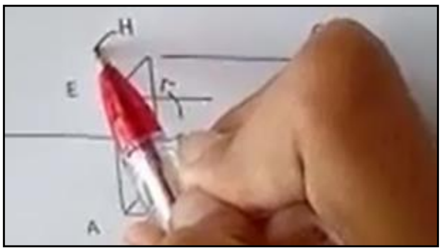

Figure 1. The Process of Representing SP. Rotation

SP : First played once for 900, then played again 900 and played again 900. A total of three times. Three times 900 equals 2700

Researcher: ok... if you play 900, what's the first one like?

SP: (silence... while crossing out questions, drawing with a pen...), if the first round the corner point A becomes E

After the subject rotates one corner point, the issue continues with another corner point, such as A becomes D, B becomes C, C becomes G, D becomes A, E becomes A, F becomes B, H becomes E, and G becomes F and so on.

SP: (while pointing the pen at the problem to show the point position) the corner point A becomes D, B becomes C, C becomes G, D becomes A, E becomes A, F becomes B, H becomes E, and G becomes F... so the answer is A

Second, spatial visualization process. The mental action taken by the subject is to read the questions slowly and then identify important information from the questions, such as determining the nets of the questions. Issues have difficulty abstractly doing spatial visualization, so the subject needs props to help the spatial visualization process.

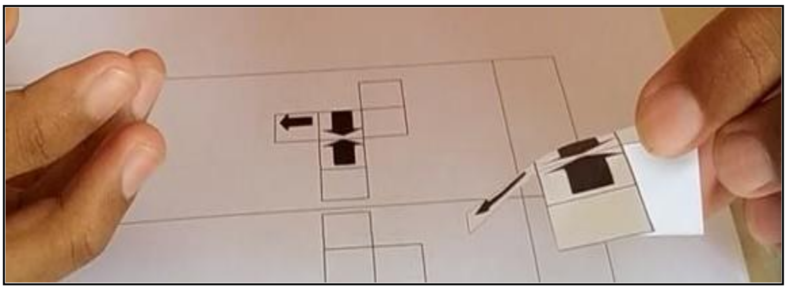

Figure 2. SP Holding and observing Props

The subject holds props. The subject observes the direction of the arrow in the question. The issue follows the path of the hand from the question and the nets being held, then matches the tip of the needle in the question with the traps the subject is holding. Next, the subject decides that the answer is A because the direction of the arrow is the same as the question. This can be seen in the maintenance results.

SP: I see the arrow's direction corresponding to the cube in question.

SP: (Ellen holds one match net while occasionally looking at the picture of the question)

Three spatial orientation process. The mental action taken by the subject is to read the question slowly and then identify important information from the problem, such as looking for the correct image of the dice when viewed from various sides. The subject can abstractly do spatial orientation by observing the position of the number of dice in picture one and picture two in the question. It doesn't take a long time; the subject's method is directing the pen to the question and observing the location or position of the dice by tilting the head left and right.

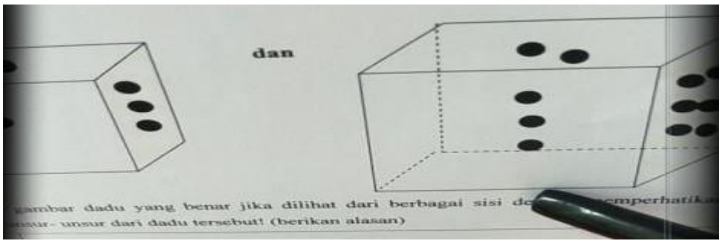

Figure 3. The Process of Observing the Position of the Dice in the SP. Problem

Next, the subject concluded that the correct answer was A. The issue reasoned that if the second picture shows dice 3, dice two, and dice six, the right position that has not been demonstrated is option A, which is one dice on the side, five dice above. Dice 4 front. This is following the results of the interview.

SP: this picture (pointing to the image of the problem) shows dice 3, dice two, and dice 6; the correct position, which is not yet visible, is option A, namely one die on the side five on the top, four front dice.

The subject confirms the answer by mentioning the wrong parts of choices B and C. According to the issue in choice B, the position of the dice should be five, while for choice C, the role of the five dice should be six.

Male Student Spatial Reasoning in Solving Geometry Problems

The first spatial rotation process. The male students read the questions and identify the information contained in the questions, such as being asked to find the position of the corner points after the ABCD EFGH cube is rotated 2700. Next, the subject performs an abstract spatial rotation by observing the problem by turning the pen pointing towards the corner point. Questions according to the directions.

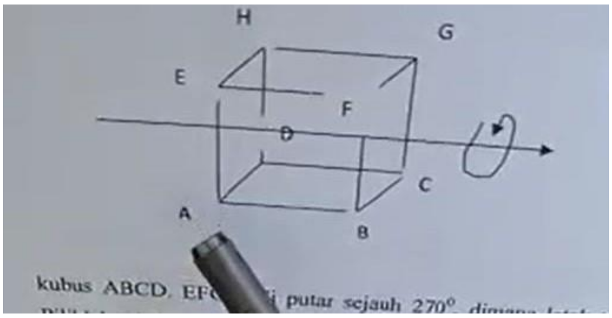

Figure 4. SLK Shows One Point Angle Rotated 2700

The subject rotates the vertex three times. However, the issue could not explain why it was played three times. The matter only explained the position of the corner points rotated 2700, such as A became point D; point D became point H, point H became fact E, and matter E became point A. Turning one corner of the subject can conclude that the correct answer is A. This follows the results of the subject's work and interviews.

SLK: asked to find the position of the corner points after the cube ABCD EFGH is rotated 2700, so it is rotated three times

Researcher: what do you mean?

SLK: yes, because 2700, then A becomes point D, point D becomes point H, point H becomes point E, and point E becomes point A.

Second spatial visualization process. The subject reads at a glance, then identifies the information in the question as if asked to find the proper nets according to the question. The subject observes the direction of the arrow in the question with the available answer choices by directing the bullet in the direction of the needle in the question and answer.

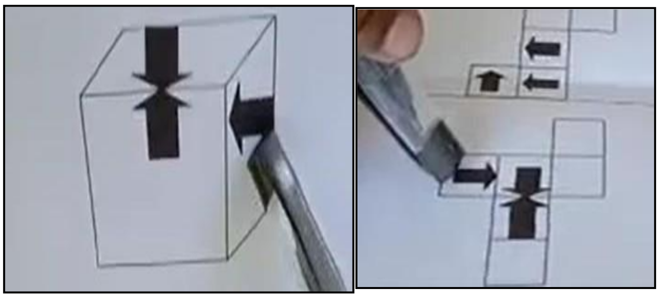

Figure 5. SLK Observing the Direction of the Question Arrows and the Nets

Subjects perform spatial visualization without using visual aids. After observing the picture of the problem and the net by looking at the direction of the arrow, the issue concluded that the correct net was A because the movement of the hand was the same as the problem. This is by the results of the subject's work and interviews.

Q: So how?

SLK: erm… this arrow's direction is the same as this (pointing to the question), then the arrow's path is the same as this (pointing to the question).

Researcher: So, what's your answer?

SLK: A, because the direction of the arrow guided me.

Three spatial orientation process. The subject reads at a glance and then identifies the information in the problem, such as being told to find the correct position of the dice point seen from various sides. The subject observed the questions and answer choices, initially responding B. However, the issue could not explain the reason and was silent. It was seen that the subject had difficulty, so the subject asked permission to use props to help with spatial orientation. Issues make dice props from cube nets.

Figure 6. SLK Making Dice Props

SLK holds the dice he made, then turns it upside down and rotates the display, only observing the picture of the problem and the nets. When watching pictures of nets and pictures of questions, male students are guided by the direction of the arrow and can determine the good yields. Meanwhile, female students have difficulty and need props in the visual-spatial process. This corresponds to the dice while observing the position of the die points. The subject realized that his initial answer was wrong. The issue explained why choice B was incorrect because the part of the front six dice should be three and finally changed the solution, namely A. The subject reasoned the same as the dice made. Where the five dice are on the top, the four dies are in front, and the one on the side, so that the position of the dice when viewed from all directions is correct. This is following the results of the interview.

SLK: one B.

Researcher: if it's wrong, which one is correct?

SLK: (flipping through the props to see the dice position). The A.

Researcher: why A?

SLK: hmm ... this is the same as the cube I made (props). The five dice are on the top, the four dice are in front, and the one is on the side. So, the position of the dice, when viewed from all directions, is the correct one A

Based on the description of the visual-spatial indicators, male students are more dominant in performing visual-spatial than female students. This can be seen when working on questions about boys without using the statement tool and stating that there are differences in spatial reasoning between boys and girls, where male students are better than girls because of physical differences. Between men and women (Even & Kvatinsky, 2010; Glynn & Winter, 2004; Ping Ong et al., 2014). Functionally, men and women also have differences. For example, men have better visibility and deeper perception than women, so men's partial visuals are more dominant.

On other indicators, the researcher found a contradiction with the results of previous studies. The first contradiction lies in the spatial orientation indicator, and female students are more dominant in spatial orientation skills than boys. This can be seen when female students can abstractly do spatial orientation by observing the position of the number of dice in the first and second images in the question, and it doesn't take long to determine the correct answer (Amran et al., 2019; P. Purba et al., 2017; Pratama & Retnawati, 2018).

The male students initially experienced errors in determining the answer due to difficulties in carrying out spatial orientation. So that male students use props to help the process of spatial orientation. This shows that female students are more dominant in spatial orientation than boys. This finding contradicts the results of previous studies, which stated that male students had better spatial reasoning than female students (Fuad et al., 2017; Zazkis & Zazkis, 2010; Zelkowski, 2010).

In addition, both do not use props in the spatial rotation indicator and can perform spatial rotation appropriately. This finding follows the results of research, which states that there is no difference in spatial reasoning between male and female students (Harjo et al., 2019; Wagner & Davis, 2010).

So, it can be stated that male students' spatial reasoning cannot be determined better than female students. Overall, the difference depends on the indicators of spatial reasoning. According to Piaget, students of ESM are in the concrete operational stage, stating that students at the concrete active stage without physical objects in front of them will have great difficulty in thinking about solving problems (Auria, 2019; Etemadzadeh et al., 2013; Handajani et al., 2018). This does not entirely follow the findings of this study; male students do not need visual-spatial visual aids. At the time of spatial orientation, male students have difficulty, so they need props to help the spatial orientation process.

Additionally, both male and female pupils rotated in space while imagining without aids. This is so that, when seen from his age, the student might be in the concrete operational stage yet be able to think abstractly about certain things. This is because each person has a varied cognitive development dependent on how to adapt to the environment and interact with the territory (Dyah KUSUMA & lisDyah KUSUMA, 2018; Omar et al., n.d.; Zubaidah, 2017). Humans progress through the following states of their cognitive development at varying rates. It's possible that an eight-year-old child's thinking is still at a pre-operational level while a six-year-old youngster is at a concrete operational level (Aini et al., 2019; Ardiansyah et al., 2018).

Conclussion

Based on our analysis and discussion results, we can conclude that there are differences in visual-spatial and spatial orientation in the spatial thinking of male and female students. Male students are more dominant in using spatial-visual skills, and female students are more predominant in using spatial orientation skills. However, both have the same ability when rotating in space. This study has limited topic selection and is recommended for other researchers. Apart from considering gender, there are also cognitive styles and other possibilities. In this way, the knowledge of spatial thinking is expanding.

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