Proceeding International Conference on Islamic Education
"Exploring Contemporary Challenges and Innovations in Education"
Faculty of Tarbiyah and Teaching Training
Universitas Islam Negeri (UIN) Maulana Malik Ibrahim Malang
October 17th, 2024
P-ISSN 2477-3638 / E-ISSN 2613-9804
Volume: 9 Year 2024

Students' Visual-Spatial Thinking Ability in Solving Geometry Transformation Problems Based on Jombangan Ethnomathematics in Junior High Schools

Ulfa Masamah*[1], Muhammad Al Farabi[2]
UIN Maulana Malik Ibrahim Malang; Jl Gajayana No.50 Kota Malang
e-mail: *[1] ulfamasamah@uin-malang.ac.id, [2]farabimuhammad01@gmail.com

Abstract. Students must have visual-spatial thinking ability in order to understand geometric transformation material which is abstract in nature and requires imagination. This research aims to analyze students' visual-spatial thinking abilities in solving geometric transformation problems based on Jombangan ethnomathematics in junior high schools. This research uses a qualitative approach with a descriptive type. The subjects of this research were class VIII students at MTs Negeri 3 Jombang who were determined using purposive sampling. Data collection techniques were carried out using tests in the context of Jombangan ethnomathematics, semi-structured interviews, observation, and documentation. The data analysis technique uses three steps, namely data reduction, data display, and conclusion/verification. The credibility test is carried out by triangulating methods and increasing persistence. The results of this research show that students at MTs Negeri 3 Jombang achieve the indicators of pattern searching and imagining more dominantly, while the indicators of problem solving and conceptualization are still lacking.
Keywords: Ethnomathematics; Jombangan; Geometry Transformation; *Visual-Spatial Thinking*

A. INTRODUCTION

Based on the level of Van Hiele Theory, each student has different basic abilities in solving various geometric problems. Looking at one of the stages of geometric thinking in Van Hiele's Theory, namely level 0 (visualization), students recognize geometric shapes based solely on their visual characteristics and appearance. Therefore, at this stage students cannot understand and determine the concepts and properties of geometry as well as the characteristics of the shapes shown (Abdussakir, 2012).

One of the materials in geometry is geometric transformation. Edward believes that knowledge about geometric transformations is very useful for students in improving spatial abilities, geometric reasoning abilities, and strengthening mathematical proofs. Geometric transformations have many roles in students' mathematical development. Edward also believes that learning geometric transformations provides various opportunities for students to develop their spatial visualization abilities and geometric reasoning to gain mathematical proof abilities (Hanafi, etc., 2017).

The National Academy of Science explains that spatial abilities or spatial thinking are needed to understand the characteristics and relationships of geometry in the process of solving mathematical problems or problems related to geometry in life (Buckley, etc., 2019; Suwito, 2020). The first step in spatial thinking is the ability to visualize (visual-spatial thinking ability), a term used to describe the combination of these two thinking abilities (Harnum, 2022). In line with Paradesa (2016) who stated that the fundamental ability of spatial thinking in learning geometry specifically is the ability to visualize. The development of visualization abilities influences spatial thinking.

The form of visual-spatial thinking ability in dealing with geometric transformation problems can be seen through the imagining process, where students imagine and determine the reflection results of an object. Conceptualizing means students analyze the process and determine a form that is not the result of a reflection transformation of an object. Problem solving (problem-solving), reflection students analyze and determine strategic steps for solving a problem reflecting an object. As well as pattern seeking, students can find patterns and determine the results of the subsequent transformation of an object. Thus, visual-spatial thinking ability refers to an individual's ability to conceptualize objects and space through the use of their imagination to represent, transform and recognize relationships between geometric shapes, as well as to solve various problems. Through students' good visual-spatial thinking abilities, it is hoped that they can help students understand geometry, especially geometric transformation material, better.

According to Haas (2003), visual-spatial abilities have differences in solving geometric problems which are used to formulate indicators of visual-spatial abilities, namely Imagining, Conceptualizing, Problem Solving and Pattern Seeking. Students who have quality visual-spatial abilities can use their imagination, which will create students who are creative and innovative in thinking to solve geometric problems. Based on the results of the pre-survey at MTs Negeri 3 Jombang, there are still many students who have difficulty thinking conceptually in terms of image patterns so that students are unable to make connections between the various types of information obtained and find it difficult to describe and describe a spatial structure. Students' abilities in drawing and using tools to draw three-dimensional spatial shapes are still low, and it is difficult to understand the images presented.

During the pre-research at MTsN 3 Jombang, researchers found students' difficulties in solving mathematical problems that emphasize the element of visualization. This causes students to find it difficult to link problem ideas with mathematical concepts. Researchers tried to identify students' visual-spatial thinking abilities with content that is close to students' lives. Therefore, researchers utilize test questions based on Jombangan ethnomathematics so that they are relevant to the environment of students who are able to develop critical and creative thinking. Researchers take some relevant research on the urgency of visual ability in learning geometry, research Anwar et al. (2022) states that the importance for teachers to know the ability of students in learning geometry by paying attention to the level of geometry thinking. Adibah (2020) states that in solving geometry problems, subjects have different visual reasoning abilities. Atikatsuri & Kusaeri (2024) states that the development of students' abilities needs to be integrated with ethnomathematics, to stimulate students to carry out problem solving activities. Based on previous research there is still no related research in analyzing students' visual-spatial thinking abilities in solving ethnomathematics problems.

This research uses questions in the context of Jombangan ethnomathematics which include Ceplok-Ceplok Jatipelem batik pattern with the aim of better exploring visual-spatial thinking abilities students at MTs Negeri 3 Jombang. Based on previous research and pre-survey results, researchers are interested in studying more deeply the visual-spatial thinking abilities of students in solving geometric transformation problems based on Jombangan ethnomathematics.

B. METHODS

This research uses a qualitative approach with a descriptive type. In descriptive research, researchers only want to collect data to describe a phenomenon that is occurring, but not to find or explain the relationship between variables. Descriptive research is research that attempts to explain actual problems, namely problems that are currently occurring or problems that arise at the present time (Sanjaya, 2013). The subjects of this research were class VIII students at MTs Negeri 3 Jombang who were determined using purposive sampling. Data collection techniques were carried out using tests in the context of Jombangan ethnomathematics, semi-structured interviews, observation and documentation. The data analysis technique uses three steps, namely data reduction, data display, and conclusion/verification. The credibility test is carried out by triangulating methods and increasing persistence.

The following are indicators of visual-spatial thinking abilities used in this research referring to the indicators used by Hass (2003).

Characteristics	Indicator
1	2
Imagining	Students understand problems based on what they see, or use the help of pictures to solve problems. Also, students are able to express their ideas or thoughts in the form of images to solve a problem.
Conceptualizing	Students are able to mention concepts related to problems and use these concepts to solve problems.
Problem-Solving	Students use the process of analysis, interpretation, reasoning, prediction, evaluation, and reflection on the solution to a problem, so that they can solve and ensure the solution correctly.
Pattern seeking	Students search for, identify and analyze patterns to solve problems correctly.

C. RESULT & DISCUSSION

The test questions for students' visual spatial thinking abilities are designed by integrating aspects of Jombangan ethnomathematics in the form of batik as the context. This is intended to stimulate the development of students' abstract thinking, problem solving, visual creativity and reasoning abilities (Zulvira & Desyandri, 2022). In this research, ethnomathematics is used in the form of both Jombangan Motif Ceplok-Ceplok Jatipelem Jombang. The batik motifs are as follows.

Figure 1 Batik Jombangan Ceplok-Ceplok Jatipelem Jombang

The questions with the Batik context were then given to all students to work on. Next, several students were taken for interviews based on the answers the students had written. The results of this research are as follows.

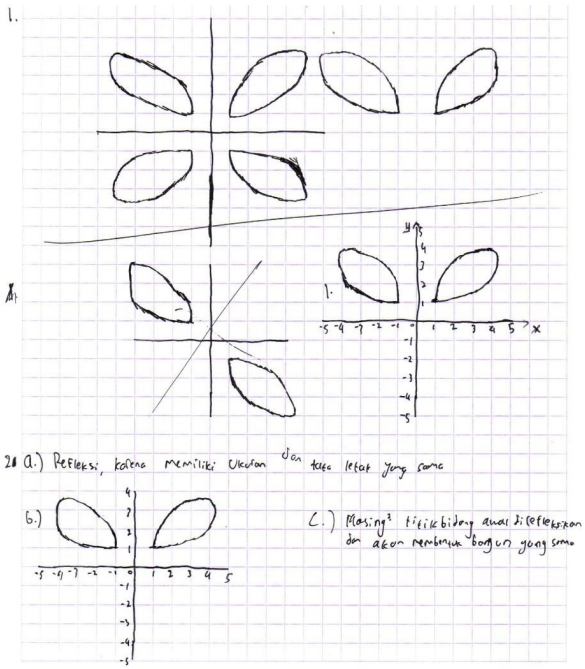

Figure 2 Subject 1 Answer

Subject 1 answered question number 1 which is an indicator of imagining with an incorrect answer. Subject 1 was able to draw a motif sketch but it was not accompanied by two axes (x-axis and y-axis), even though these two axes were the main elements which showed that the motif sketch was in the Cartesian coordinate plane. However, Subject 1 was able to explain that the sketch was in the Cartesian coordinate plane clearly and revealed that he had forgotten because he had not written the x-axis and y-axis. Subject 1 answered question number 2a which is an indicator of conceptualizing with the correct answer, Subject 1 answered question number 2a which is an indicator of conceptualizing with an incorrect answer. This can be seen frjom Subject 1 being able to analyze and interpret the concept of geometric transformation used, namely reflection, by conveying reasons that are not quite right. Subject 1 shows that objects are said to experience reflection because they have the same size and layout. Subject 1 answered question number 2b which is an indicator of pattern seeking with an inaccurate answer. This can be seen from Subject 1 being able to find and abstract on the Cartesian plane the geometric transformation pattern of the problem correctly but not completely in describing the line of reflection. Subject 1 answered question number 2c which is an indicator of problem-solving with an inaccurate answer. Subject 1 was able to determine the characteristics of the reflection transformation of the motif sketch image correctly, but did not show evidence of the coordinates of the object experiencing the reflection between the initial point and the resulting point of reflection.

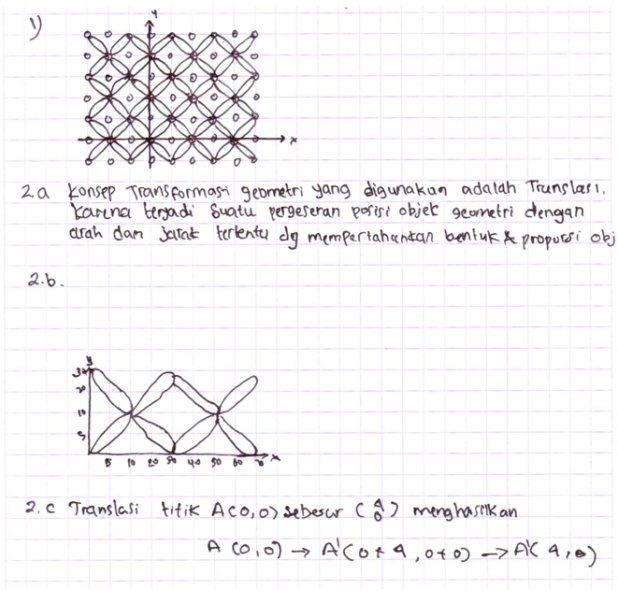

Figure 3 Subject 2 Answer

Subject 2 answered question number 1 which is an indicator of imagining with the correct answer. Subject 2 was able to depict motif sketches on the Cartesian plane accurately and completely. Subject 2 answered question number 2a which is an indicator of conceptualizing with the right answer, Subject 2 answered question number 2a which is an indicator of conceptualizing with the right answer. This can be seen from Subject 2 being able to analyze and interpret the geometric transformation concept used, namely translation, due to a shift in the position of a geometric object in a certain direction and distance while maintaining the shape and proportion of the object. Subject 2 answered question number 2b which is an indicator of pattern seeking with an inaccurate answer. This can be seen from Subject 2 being able to find and abstract on the Cartesian plane the geometric transformation pattern of the problem completely but not quite precisely in describing the magnitude of the coordinate point that has shifted, namely 5 , 10, 20, 30 and so on. Apart from that, the motif sketch in number 2b and the point completion analysis in number 2c are inconsistent. Subject 2 answered question number 2c which is a problem-solving indicator with the correct answer. Subject 2 was able to determine the characteristics of the transformation and steps/translation process of the motif sketch image correctly, namely the shift in the point of the batik object, namely the point $A(0,0)$ as big as $(4\ 0\ )$ which produces a point$A'(4,0)$.

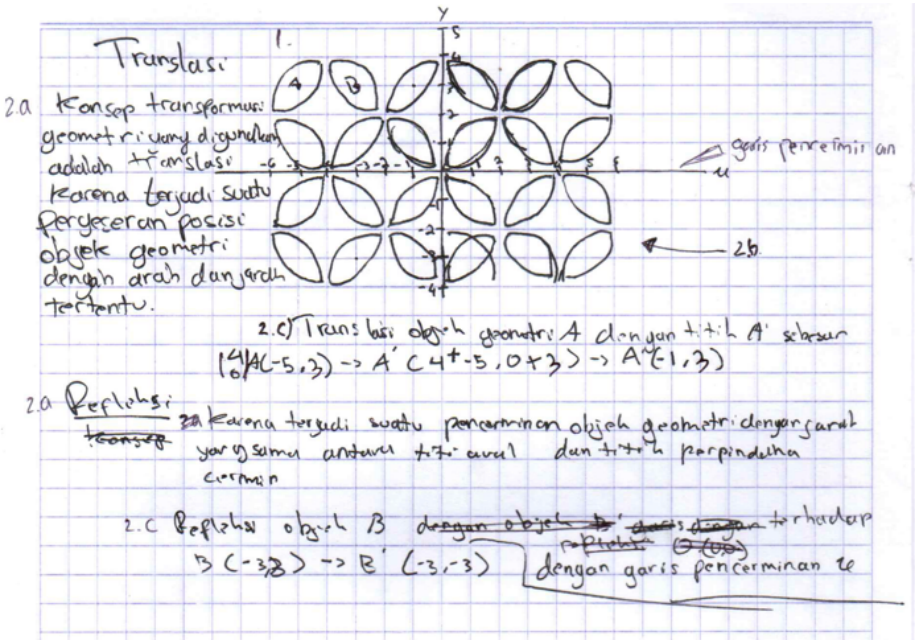

Figure 4 Subject 3 Answer

Subject 3 answered question number 1 which is an indicator of imagining with the correct answer. Subject 3 was able to depict motif sketches on the Cartesian plane accurately and completely. In this case. Subject 3 answered question number 2a which is an indicator of conceptualizing with the correct answer. Subject 3 was able to analyze and interpret the two concepts of geometric transformation used, namely translation due to shifts occurring with certain rules and reflection due to reflection occurring with certain conditions. Subject 3 answered question number 2b which is an indicator of pattern seeking with an inaccurate answer. Subject 3 was able to find and abstract on the Cartesian plane geometric transformation patterns using the sketch image in number 1 but was incomplete in describing the transformation result points between points resulting from translational or reflection transformations. Subject 3 answered question number 2c which is a problem-solving indicator with the correct answer. Subject 3 was able to determine the characteristics of the transformation and steps/process of translation and reflection from the motif sketch image correctly.

Overall, it can be seen from the four elements of visual-spatial thinking ability that students tend to have incorrect answers on the pattern seeking indicator. Octaviani et al. (2021) revealed that students can find patterns formed in geometry problems, then these students can be categorized as having good visual spatial abilities. From the results of student work, it can be seen that students have not been able to find patterns that are formed according to the problems presented so that it can be said that students do not have good abilities. This is in line with Harnum (2022) which found that the need for visual-spatial thinking abilities in solving geometry transformation problems so that they can solve problems appropriately.

In solving a math problem, it is certainly related to students' knowledge and understanding of a mathematical concept (Prastyo, 2020) So, when students do not understand a concept, then the success of students in solving a problem becomes less precise. The ability of visual-spatial thinking in mathematics learning, especially in geometry, can help students build geometric understanding and make it easier to solve geometry problems (Fitriyani et al., 2023; Goldsmith et al., 2016) Students who have good visual-spatial thinking abilities can have various positive impacts on their education and development (Harnum, 2022). Some of the positive impacts that students can feel include being able to improve students' concept understanding, train problem solving abilities, and increase success in Science, Technology, Engineering, and Mathematics learning (Fitriyani et al., 2023; Harnum, 2022). The results of the study related to students' spatial abilities in this research can be initial information to help educators and educational institutions in developing more appropriate

and focused learning strategies to improve students' visual-spatial thinking abilities. If teachers can understand students' visual-spatial thinking abilities, they are able to develop more effective teaching methods, including using teaching strategies that rely on the strengths of visual-spatial thinking. With a better understanding of students' visual-spatial thinking abilities, educators can provide direction and support to further their interests and talents in these areas.

The results of this research are in line with previous research conducted by Kiernan, et al (2021) which states that being able to pass each indicator of students' visual-spatial thinking ability well is certainly not easy, because it requires sufficient spatial-related reasons and must have a variety of solution strategies. problem. These students' visual-spatial thinking abilities are also influenced by the construction of spatial abilities based on Van Hiele's theory (Pujawan, et al., 2020). This is because visual thinking abilities in solving problems that require high-level reasoning, than visual thinking becomes the most important thing in the success of geometry learning for students who did misconceptions if they study without using visual thinking abilities (Sumarni & Prayitno, 2016).

.

D. CONCLUSION

Based on the results of the research and discussion, the conclusion of this research is that MTs Negeri 3 Jombang students are able to search, identify and analyze patterns to solve problems appropriately (pattern search indicators) and are able to analyze and abstract ideas or the results of their thoughts into shape the image correctly (indicator of imagination), while indicators of problem solving and conceptualization are still lacking. This is because in the concept indicator, students are required to be able to interpret the concept of geometric transformations used, express reasons and statements correctly but students are not yet able to do this. Students' inability to conceptualize affects students' problem solving abilities, especially when questions are presented in a class ethnomathematics context that they are not used to.

Recommendation for further research by conducting research on learning interventions based on visual-spatial thinking abilities. Teachers need to accommodate students' spatial abilities with learning that is able to develop students' visual-spatial thinking abilities. This can be done by using learning media that applies constructivist theory, one of which is the use of Augmented Reality (AR) based media, Geogebra, and other relevant media.

REFERENCES

Abdussakir. (2012). Pembelajaran Geometri Sesuai Teori Van Hiele. *Madrasah 2 (1)*.

Adibah, F. (2020). Analisis Kemampuan Penalaran Visual Mahasiswa dalam Menyelesaikan Masalah Geometri. *WIDYALOKA*, *7*(2), 242-254.

Anwar, A., Takaendengan, B. R., Nirwana, L., & James, J. (2022). Analisis Kecerdasan Spasial Siswa dalam Menyelesaikan Soal-Soal Geometri Berdasarkan Tingkat Berpikir Van Hiele. *Jurnal Pendidikan Matematika: Judika Education*, 5(2), 116-125.

Atikasuri, A., & Kusaeri, A. (2024). Analisis Kemampuan Representasi Matematis Siswa dalam Memecahkan Masalah Matematika Berbasis Etnomatematika Kain Tenun Lombok. Kognitif: Jurnal Riset HOTS Pendidikan Matematika, 4(1), 353-367. https://doi.org/10.51574/kognitif.v4i1.1486

Buckley, J., dkk. (2019). Investigating The Use of Spatial Reasoning Strategies In Geometric Problem Solving. *International Journal of Technology and Design Education*, 29(2).

Fitriyani, A. M., dkk. (2023). Analisis Kecerdasan Logis Matematis Dan Visual Spasial Dalam Menyelesaikan Soal Geometri. *Jurnal Kongruen*, *2*(4). https://jurnal.unsil.ac.id/index.php/kongruen

Goldsmith, L. T., dkk. (2016). Visual-Spatial Thinking in Geometry and The Visual Arts. *Psychology of Aesthetics, Creativity, and the Arts*, *10*(1). https://doi.org/10.1037/aca0000027

Haas, S. C. (2003). Algebra for Gifted Visual-Spatial Learners. *Gifted Education Communicator (Spring)*, *34*(1).

Hanafi, dkk. (2017). Transformasi Geometri Rotasi Berbantuan Software Geogebra. *Fibonacci Jurnal Pendidikan Matematika dan Matematika* 3 (2).

Harnum, T. S. (2022). Analisis Kemampuan Visual Spatial Thinking Siswa SMA pada Materi Transformasi Geometr*i*. *Skripsi*. [Tidak Diterbitkan]. UIN Syarif Hidayatullah Jakarta.

Kiernan, N. A., dkk. (2021). The Role of Visuospatial Thinking in Students' Predictions of Molecular Geometry. Chem. Educ*. Res. Pract (626-639).* https://doi.org/*10.1039/D0RP00354A*

Octaviani, K. D., Indrawatiningsih, N., & Afifah, A. (2021). Kemampuan Visualisasi Spasial Siswa Dalam Memecahkan Masalah Geometri Bangun Ruang Sisi Datar. *International Journal of Progressive Mathematics Education*, *1*(1), 27–40. https://doi.org/10.22236/ijopme.v1i1.6583

Paradesa, R. (2016). Pengembangan Bahan Ajar Geometri Transformasi Berbasis Visual. *Jurnal Pendidikan Matematika JPM RAFA*, *2*(1), 56–84.

Prastyo, H. (2020). Kemampuan Matematika Siswa Indonesia Berdasarkan TIMSS. *Jurnal Paedegogik*, *3*(2), 111–117. https://doi.org/10.35974/jpd.v3i2.2367

Pujawan, I. G. N., Suryawan, I. P. P., & Prabawati, D.A.A. (2020). The Effect of Van Hiele Learning Model on Students' Spatial Ability. *International Journal of Instruction*, Vol.13 No. 3 Pp. 461-474

Sanjaya, W. (2013). *Penelitian Pendidikan Jenis, Metode, dan Prosedur,* ed. Riefmanto, 1st ed. (Jakarta: KENCANA.

Sumarni, S., & Prayitno, A. T. (2016). Kemampuan Visual-Spatial Thinking Dalam Geometri Ruang Mahasiswa Universitas Kuningan. *JES-MAT (Jurnal Edukasi Dan Sains Matematika), 2(2).* https://doi.org/10.25134/jes-mat.v2i2.349

Suwito, A. (2020). *Reproduksi Visual Spasial Alternatif Pemecahan Masalah Jarak Titik Dan Bidang*. Bentara Pustaka.

Zulvira, R., & Desyandri. (2022). Pengembangan Bahan Ajar Interaktif Tematik Terpadu Menggunakan Steam Berbasis Lectora Di Kelas III SD. *Jurnal Cakrawala Pendas*, *8*(4), 1273–1286. https://doi.org/10.31949/jcp.v8i4.3133