

Visual Thinking Ability of Mathematics Education Students on Geometry Transformation Learning Material

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ABSTRAK

Pemecahan suatu masalah pada transformasi geometri yang diutamakan adalah kemampuan berpikir visual, hal ini dikarenakan visualisasi merupakan jantungnya matematika untuk menyelesaikan suatu permasalahan, selain itu visualisasi juga dapat mempermudah memahami matematika yang bersifat abstrak, serta dapat dijadikan sebagai strategi penyelesaian dari persoalan matematika menjadi sangat sederhana. Penelitian ini bertujuan untuk mendeskripsikan kemampuan berpikir visual mahasiswa pendidikan matematika pada materi transformasi geometri. Jenis penelitian yang digunakan dalam penelitian ini adalah penelitian deskriptif kualitatif. Subjek dalam penelitian ini adalah 5 orang mahasiswa. Tes tertulis yang berhubungan dengan soal transformasi geometri, seperti soal, refleksi, translasi, dan dilatasi dijadikan sebagai sumber data dalam riset ini. Dengan mendeskripsikan setiap instrument yang telah dikerjakan oleh mahasiswa sesuai dengan indikator kemampuan berpikir visual adalah teknik analisis data yang digunakan. Hasil penelitian ini menunjukkan bahwa kemampuan berpikir mahasiswa hanya sampai pada tahap memilah, mencari, dan menemukan. Artinya hanya sampai pada perolehan dan penalaran. Hal ini terlihat dari respon beberapa mahasiswa, yakni mahasiswa (1) empat tahapan dan tiga prinsip kemampuan berpikir visual tercapai. Mahasiswa bisa memilah pertanyaan yang diberikan dan mencari informasi untuk memperoleh jawaban, serta dapat mendeskripsikan dan memvisualkan jawaban yang telah diperoleh. Respon mahasiswa (2) hanya tidak sampai pada langkah mendeskripsikan dan prinsip individuasi. Artinya mahasiswa tidak bisa menjelaskan dan menguraikan jawaban ke dalam bentuk gambar atau grafik secara tepat. Respon mahasiswa (3) hanya sampai pada tahap memilah dan perolehan atau dengan kata lain cuma mengerti dari apa yang ditanyakan. Mahasiswa pada respon (4) hanya tidak sampai pada langkah mendeskripsikan dan prinsip memvisualkan/menggambarkan. Sehingga dapat dijadikan sebagai referensi yang berkaitan dengan penelitian visual, terutama pada materi geometri.

Kata kunci: Kemampuan Berpikir Visual, Mahasiswa Pendidikan Matematika, Transformasi Geometri

ABSTRACT

Solving a problem in geometric transformation that is prioritized is the ability to think visually, this is because visualization is the heart of mathematics to solve a problem, besides that visualization can also make it easier to understand abstract mathematics, and can be used as a strategy for solving mathematical problems to be very simple. This study aims to describe the visual thinking ability of mathematics education students on the material of geometric transformation. The type of research used in this research is descriptive qualitative research. The subjects in this study were 5 students. Written tests related to geometric transformation questions, such as questions, reflections, translations, and dilations were used as data sources in this research. By describing each instrument that has been done by students in accordance with the indicators of visual thinking ability, data analysis techniques are used. The results of this study indicate that students' thinking skills only reach the stage of sorting, searching, and finding. It means only to the acquisition and reasoning. This can be seen from the responses of several students, namely students (1) four stages and three principles of visual thinking ability are achieved. Students can sort out the questions given and look for information to get answers, and can describe and visualize the answers that have been obtained. Student response (2) only did not reach the step of describing and the principle of individuation. This means that students cannot explain and describe answers in the form of pictures or graphs correctly. Student responses (3) only reached the stage of sorting and obtaining or in other words only understanding what was asked. Students in response (4) only did not reach the step of describing and the principle of visualizing/illustrating. So that it can be used as a reference related to visual research, especially on geometry material.

Keywords: Visual Thinking Ability, Mathematics Education Students, Geometry Transformation

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Introduction

Consciously or unconsciously, humans often do thinking activities. Whatever the problem is, it must be thought of to be solved. Even when a baby is born, the thought process has actually occurred, this is shown when the baby is born crying immediately. Humans do not think only during sleep or are not breathing. Thinking is a process of doing new ideas or ideas (Suripah & Sthephani, 2017). According to mental activity that usually occurs when someone faces a problem, it is a thinking activity that requires a way to be solved (Syahfirza & Hutama, 2019). Situations like this make people compelled to use their abilities, both knowledge and skills, to be able to find the correct and appropriate solution or solution to what they are experiencing (Aini & Hasanah, 2019). This shows that when someone faces a problem, they will automatically think about how to solve it. When connected with the senses, there are three ways of thinking, namely auditory thinking (hearing), kinesthetic thinking (feeling) and visual thinking (seeing) (Sumarni & Prayitno, 2016). Of the three ways of thinking, visual thinking can be used as an alternative by students in solving mathematical problems, especially those related to geometry. Mathematics teaching is more effective when it includes diagrams, pictures, pictures, etc. that visually represent concepts and relationships (Batista, 2018). But not all students can make visualization the answer in solving a problem. The reality in the field is that students are still accustomed to solving geometric problems analytically compared to visuals, so that when problems want a visual solution, students tend to answer with analytical solutions (Rifat, 2014). As seen from the answers of the sixth semester students of STKIP Pamane Talino, it appears that students can only answer with analytical descriptions, but when visualizing errors made by students, students should answer point $P'(5,4)$, but students only represents $P'(x',y')$. From cases like this, it can be seen that the students' thinking skills are mainly related to visual thinking. This is because the problems in the transformation of geometry by itself will always be accompanied by visualization. For this reason, it is very important for students to have the ability to think visually (visual thinking). From cases like this, it can be seen that the students' thinking skills are mainly related to visual thinking. This is because the problems in the transformation of geometry by itself will always be accompanied by visualization. For this reason, it is very important for students to have the ability to think visually (visual thinking).

According to Arcavi visual thinking is the ability, process and product of creating, interpreting, using and reflecting on images, pictures, diagrams, in our minds, on paper or with technological tools, with the aim of describing and communicating information, thinking and developing ideas previously unknown and advances understanding (Bishop, 2011). In line with Arcavi's opinion, Zimmermann and Cunningham also define visualization as the process of forming images (mentally, or with pencil and paper, or with the help of technology) and using these images effectively for mathematical discovery and understanding (Ozkaya et al., 2016). Visualization refers more to producing and using geometric representations such as diagrams, graphs, images in the process of solving mathematical questions (Ozkaya et al., 2016). In this study, visual thinking skills are more directed at drawings and graphics as a result of solving geometric transformation problems. This is because visual thinking skills play a role in solving problems that require high-level reasoning, so visual thinking becomes the most important thing in the success of geometry learning for students who are prone to misconceptions if they study without using visual thinking skills (Sumarni & Prayitno, 2016) .

Thornton argues that visual thinking skills can be used as an approach in problem solving, especially to improve mathematical results, visual forms can often give the impression of being

simple, elegant, and in the process of establishing relationships between various fields of mathematics (Nuridin, 2015). In line with Thornton's opinion, visual understanding can also be seen as a means to an end, but not as an end in itself (Bishop, 2011). Visualization plays a fundamental role in every concept or process development, including problem solving, so that in representing it it is necessary to pay attention to three basic principles of visualization, namely: (1) Acquisition principle: Individuals capture the intended meaning of visual representations involving everyday objects through visualization. the use of one strategy or a combination of two or more strategies; (2) The principle of reasoning: Many problem solvers use imaginative reasoning in organizing their thinking and as an alternative to purely symbolic or linguistic forms of reasoning. Imaginative reasoning often leads to meaningful associations, analogies, conclusions, and relational structures; (3) The principle of individuation: While an individual's ability to represent visually is influenced by one's visual system, it is also influenced by socially shaped practices (Bishop, 2011). In this study, the meaning of the three principles are: (1) The principle of acquisition, it is intended that students understand what is being asked; (2) The principle of reasoning, namely being able to seek and find solutions to what is asked; (3) The principle of individuation is to be able to visualize the answers that have been obtained. According to Presmeg (Ariawan, 2017) there are seven roles of visual thinking, namely: (1) Understanding the problem, how the elements in the problem relate to each other can be understood by students is the problem is represented; (2) Simplification of problems, visualization can make it easier for students to identify problems to be simpler, formalized and the methods used for resolution are also identified; (3) The interrelationships between issues; (4) Understanding individual learning styles, when representing visually when solving problems, each student has its own characteristics; (5) Another alternative of calculation, without calculating the solution of the problem can be obtained directly from the visualization itself; (6) Correction tools, the correctness of an answer to a problem, can be checked through visualization; (7) The problem is converted into mathematical form, from visual representation to problem solving, then the mathematical form can be obtained.

Methods

The method in this study uses a qualitative descriptive type of research. The research procedure starts from making UAS questions. Then from the questions that are done by students, they are analyzed based on the steps of visual thinking skills (visualization) are look, see, imagine, show (Bolton, 2011): (1) sorting, which is collecting information based on things that are known and asked, (2) searching, namely choosing a suitable pattern to solve the problem being asked; (3) a solution, namely obtaining an answer using the pattern that has been selected; (4) describe, namely explain and describe the results obtained. With the aim of seeing the extent to which students' visual thinking skills learn geometric transformations. The answers from students to these questions were used as a source of data in this research, with a total of 5 students. The research instrument used in the form of a written test that relates to geometric transformation questions, such as questions, reflections, translations, and dilations. Test questions in the form of essays were used as a data collection technique. The data analysis technique in this study is to describe each instrument that has been done by students in accordance with the steps of visual thinking skills adopted from Bolton.

Results and Discussion

Developing problem solving skills is an important goal of learning mathematics (Muflihatusubriyah et al., 2021). In other words, the heart of mathematics is the ability to solve problems. Problem solving activities in mathematics can train students to conduct experiments, observations, explorations and investigations by directing all their abilities (Sumargiyani et al.,

2021). Visualization is the ability to see and understand problem situations (Surya et al., 2013), meaning that visualization is the core of problem solving in mathematics. According to Sword, visualization is most efficient, when the material is presented using diagrams, flowcharts, timelines, films, and demonstrations (Sundari & Prabawati, 2019). The results of this research were obtained from analyzing the answers of mathematics education students' work on Geometric Transformation material. The following describes some student opinions on the problem of geometric transformation. In the problem "Knowing triangle ABC with points A (2,2), B (5,2), and C (6,6), determine and draw the image of triangle ABC reflected on the y-axis" the student's answer obtained can be seen in Figure 1.

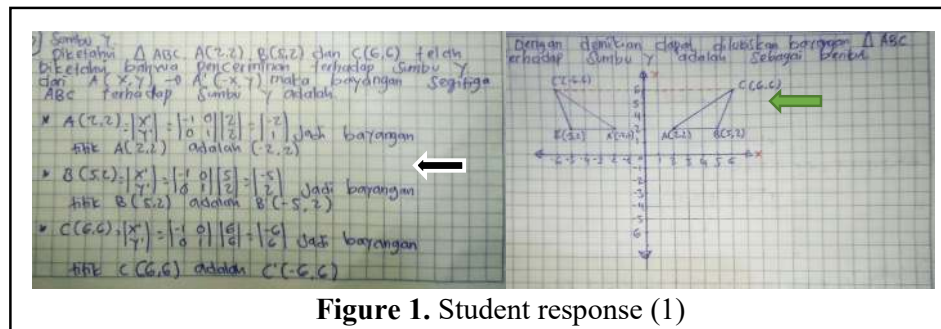


Figure 1. Student response (1)

In student responses (1) Figure 1, it can be seen that students answered correctly and correctly. Students can determine the image about the y-axis gradually from each triangle point, such as the image from point A (2,2) is A' (-2,2), point B (5,2) is the image B' (-5, 2) and point C (6.6) the reflection is C'(-6.6), its relationship with the stages of visual thinking skills means that students are able to collect and sort information from what is known and asked, students are able to choose and look for patterns that are suitable for solve problems, and are able to obtain solutions using the selected pattern (as indicated by the black arrow), and are able to describe well the results obtained (indicated by the green arrow). This means that based on the steps of visual thinking skills, response students (1) fulfill the four stages of visual thinking steps. Students understand the questions from the questions given which can be seen from the description of the answers by determining the reflection of points A, B, and C on the y-axis on triangle ABC gradually correctly, so that the visualized triangle image is also correct. Meanwhile, based on the principles of visualization, it means that students understand or understand the problems given so that they can find and describe the answers that have been obtained in visual form correctly.

In the problem "It is known that point P (3,4) determines and draws the image of point P reflected on the mirror. $y = x$ ". The results given by students are as shown in Figure 2. In Figure 2, the answers given by students (2) are correct. Students are able and understand in choosing information based on what is known and asked. Students understand that the question command asks to determine and paint the image of a point on the reflection $y = x$, then students can choose and look for a suitable pattern from the problems that have been provided as shown in Figure 2 (marked with blue arrows) so that the shadow from point P (3,4) is P'(4,3), which means that by using the pattern that has been chosen, students have obtained an answer. Meanwhile, if it is related to the principle of visualization, the principles of acquisition and reasoning are fulfilled, but students are weak in describing what is shown in the graph in Figure 2 above (marked by a yellow arrow), what should be drawn is a dot but what the student draws is a triangle, meaning that the image depicted is not in sync with the command questions. It can

be said that students are only able to step one to three, can only sort, search and find answers. This means that in relation to the principle of visualization, students only come to the principle of acquisition and reasoning. As for the fourth step and the principle of individuation has not been fulfilled, it was explained earlier that the drawings done by students were not systematic with the command questions, which were asked to describe a point, which was answered by a triangle, so that the flow of problem solving might not be understood by the reader.

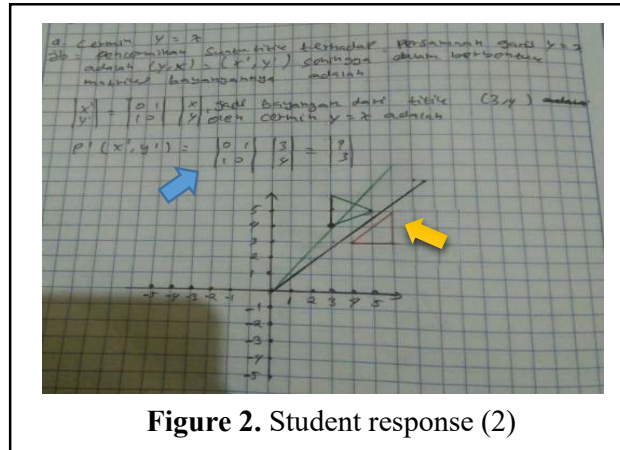


Figure 2. Student response (2)

For the problem "Know the points A (2,0), B (4,0), and C (3,3) draw $T_{AB} = C'$?"

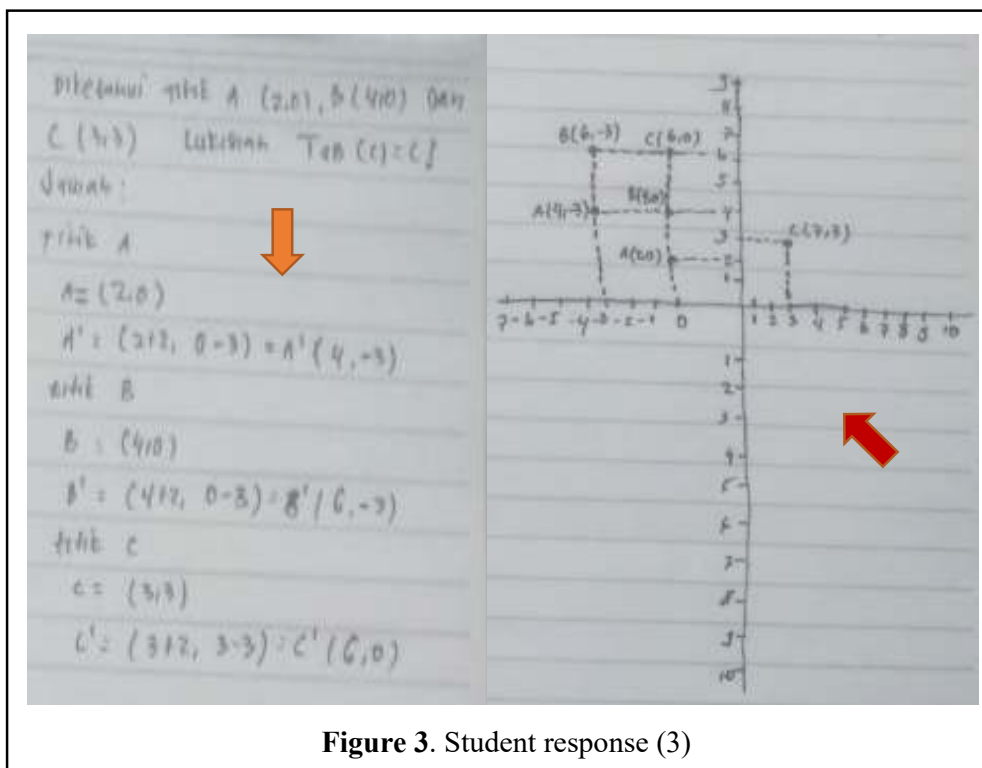
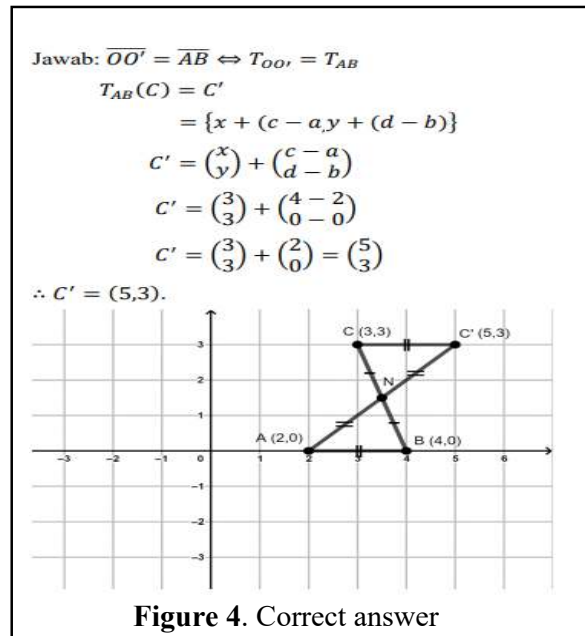


Figure 3. Student response (3)

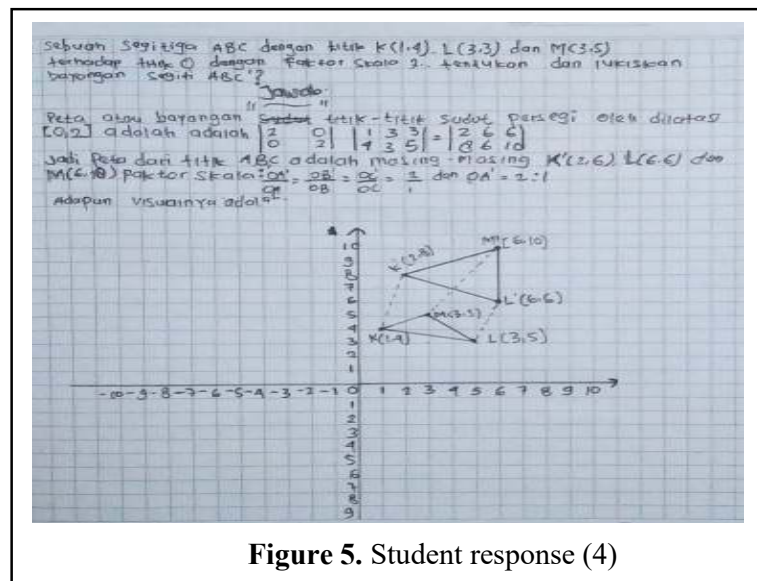
In the student response (3) in Figure 3, it can be seen that the answers made by students are not quite right. Students are only able to collect information based on what is known and what is being asked or in other words students only understand the commands of the questions. Students

have not been able to find and find a suitable solution to solve the problem, the student's answer should immediately look for C' which is translated from A to B , but what is done is like Figure 3 above (orange arrow) resulting in the answer obtained does not match the chosen pattern. and is used, and the impact also on the resulting image is far from expected (red arrow), it should be like Figure 4 below.



Thus, when viewed from the steps and principles of visual thinking skills, students' abilities only arrived at the initial stage of visual thinking skills (sorting stage) and the acquisition principle, while the steps for searching, finding and describing/visualizing as well as the principles of reasoning and individuation had not yet arrived.

The problem of the form "A KLM triangle with points K (1,4), L (3,3), and M (3,5) gets dilated to point 0 with a scale factor of 2. Define and draw the image of the KLM triangle?"



The results made by students in Figure 5 are correct. Students understand the questions given, and can seek and find answers to these problems. Students can determine the image of the ABC triangle which is dilated by a scale of 2 to the point O. However, in describing or visualizing, the answers obtained by students are not accurate, which should be dilated on a scale of 2 from point K (1,4), L (3,3), and M (3,5) are K'(2.8), L'(6.6), and M' (6.10), but what the student draws in the picture at the point L (5.3) so as to result in the resulting image is not satisfactory. So, the steps and principles of visual thinking skills that have not been achieved by students are at the stage of describing or visualizing the answers that have been obtained.

So, from some of the student responses above, student responses (1) four stages and three principles of visual thinking ability were achieved. Student response (2) only did not reach the step of describing and the principle of individuation. Student response (3) only reached the stage of sorting and acquiring. Students in response (4) only did not reach the step of describing and the principle of visualizing/illustrating.

Conclusion

Based on the results of the discussion that has been described, it can be concluded that students' thinking abilities only reach the stage of sorting and searching (acquisition), then finding (reasoning) stage. This means that when the stage of describing or visualizing in the form of images or graphics has not been achieved by students. Thus, students' thinking skills at the visualizing stage need to be followed up, namely by providing questions related to geometry that require answers in the form of images or graphics.

References

- Aini, S. D., & Hasanah, S. I. (2019). Berpikir Visual dan Memecahkan Masalah: Apakah Berbeda Berdasarkan Gender? *JNPM (Jurnal Nasional Pendidikan Matematika)*, 3(2), 177. <https://doi.org/10.33603/jnpm.v3i2.2192>
- Ariawan, R. (2017). Pengaruh Pembelajaran Visual Thinking Disertai Aktivitas Quick on the Draw Terhadap Kemampuan Pemecahan Masalah Dan Komunikasi Matematis. *Jurnal Penelitian Dan Pembelajaran Matematika*, 10(1). <https://doi.org/10.30870/jppm.v10i1.1193>
- Batista, K. S. S. M. M. T. (Ed.). (2018). *Vizualising Mathematics The Role of Spatial Reasoning in Mathematical Thought*. pringer Nature Switzerland AG 2018. <https://www.springer.com/series/13030>
- Bishop, A. J. (Ed.). (2011). *Toward a Visually-Oriented School Mathematics Curriculum*. Springer Dordrecht Heidelberg London New York. <https://doi.org/10.1007/978-94-007-0014-7>
- Bolton, S. (2011). *The Visual Decoding Design Research Data*. 277–291.
- Muflihatusubriyah, U., Utomo, R. B., & Saputra, N. N. (2021). Analisis Kemampuan Pemecahan Masalah Matematis Siswa Berdasarkan Disposisi Matematis. *AlphaMath : Journal of Mathematics Education*, 7(1), 49. <https://doi.org/10.30595/alphamath.v7i1.9936>
- Nurdin, E. (2015). *Pengaruh Pembelajaran Dengan Pendekatan Visual*. 5(2), 117–126.
- Ozkaya, M., Ocal, M. F., & Konyalioglu, A. C. (2016). Visualization in Solving Inequality Questions: Case of Pre-Service Mathematics Teachers. *Journal of Education and Human Development*, 5(4), 119–137. <https://doi.org/10.15640/jehd.v5n4a12>
- Rif'at, M. (2014). Kajian Mengenai Representasi Visualistik dan Kemampuan Menyelesaikan Masalah Matematika. *Jurnal Pendidikan Dasar*, 2(2), 94–112.
- Sumargiyani, S., Yusnia, I., Nurhasanah, R., & Nafi'ah, B. (2021). Analisis Kesalahan

- Mahasiswa dalam Menyelesaikan Soal Kalkulus. *AlphaMath : Journal of Mathematics Education*, 7(1), 20. <https://doi.org/10.30595/alphamath.v7i1.8590>
- 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>
- Sundari, E., & Prabawati, M. N. (2019). *Analisis Kemampuan Visual Thinking Dalam*. 1(2), 38–45.
- Suripah, S., & Sthephani, A. (2017). Kemampuan berpikir kreatif matematis mahasiswa dalam menyelesaikan akar pangkat persamaan kompleks berdasarkan tingkat kemampuan akademik. *Pythagoras: Jurnal Pendidikan Matematika*, 12(2), 149–160. <https://doi.org/10.21831/pg.v12i2.16509>
- Surya, E., Sabandar, J., Kusumah, Y. S., & Darhim. (2013). Mathematical Problem Solving by Schoenfeld.pdf. *IndoMS. J.M.E*, 4(1), 113–126. <https://ejournal.unsri.ac.id/index.php/jme/article/view/568>
- Syahfirza, A., & Hutama, R. (2019). Kemampuan Berpikir Visual Siswa Pada Materi Geometri. *Priosiding Seminar Nasional Matematika Dan Pendidikan Matematika Sesiomadika 2019, 2011*, 1008–1014.