STUDENT’S DIFFICULTIES IN TRANSFORMATION GEOMETRY COURSE VIEWED FROM VISUALIZER VERBALIZER COGNITIVE STYLE

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Abstract:
This study aims to determine the difficulties of students in the geometry transformation course in terms of visualizer and verbalizer cognitive style, especially in the concept of mapping a transformation. This research is a qualitative descriptive study. Based on the results of the study, it was found that the difficulties of students with cognitive visualizer and verbalizer styles tended to be the same, which included (1) difficulty visualizing the definition of a transformation (2) difficulty in proving a transformation (3) difficulty determining the result area of a mapping. The Visualizer Subject answers all the questions given and tries to describe the definition of the transformation given, although it is still not precise, it is better than the verbalizer’s. Verbalizer subjects who are essentially easier to process information in the form of writing, are constrained by the arrangement of mathematical sentences and mathematical symbols which make the subject reluctant to try to answer questions. From the results of the analysis it was also revealed that the causes of the subject's difficulties were influenced by lack of mastery of basic geometric concepts, weak of reasoning ability and difficulties in mathematical operations.

Keywords: Student Difficulties, Transformation Geometry, Visualizer Verbalizer Cognitive Style

Introduction

Geometry is a branch of mathematics that is sometimes feared by some students. The ability to interpret images, symbols and the ability to prove geometrical theorems is still a problem for some prospective mathematics teacher students. This is a glimpse of the experience of researcher who teach geometry courses. Still based on the experience of researcher, from several geometry courses that must be taken by prospective mathematics teacher students, namely basic geometry, analytical geometry and transformational geometry, it is transformational geometry that students are least interested in. Their lack of enthusiasm is caused by the difficulties they face in the course. These difficulties lead to errors in problem solving (Supardi, et, al, 2021).

In fact, this transformation geometry discusses the transformation concepts they have learned in school. The fundamental difference from the material at school for the concept of transformation in college, is that it is more expanded and explores the origins of formulas that are sometimes given directly at school. The ability to interpret theorem sentences into descriptions of geometric objects is a vital ability that must be mastered by prospective mathematics teacher students. Facts in the field revealed that many students were reluctant to try to understand the theorem language in geometry because the arrangement of the mathematical sentences used was difficult for them to understand. Sundawana (2018) found 5 types of student difficulties in terms of epistemology related to transformation geometry courses, namely a) learning difficulties related to difficulties in applying concepts; b) learning difficulties related to visualizing geometric objects; c) learning difficulties related to difficulties in determining principles; d) learning difficulties related to understanding the problem and e) related to the difficulty in mathematical proof. Especially in mathematical proof, students experience difficulties, including: not knowing how to start proof construction, not being able to use definitions (concepts) and principles that are already known, and tend to start proof construction with what needs to be proven.

According to Subekti (2015) reveals that the problems students often experience in studying transformation geometry courses are difficulties in describing transformation forms which include shifts, rotations, and dilations of point shapes, lines and fields. In addition, students also find it difficult to convey the idea of transforming a function. This problem is a serious problem that must be given a solution. If the delivery of this learning concept fails to do so it can have a bad effect in the future.

In learning transformation geometry, visualization assistance is needed which can use mathematical applications, (Hanafi, 2017; Aini, dkk, 2020). Thus, this aspect requires the ability to reason. The ability to reason in visualizing information is closely related to cognitive abilities. The way a person receives this information is called a cognitive style. The information that students receive in the form of visual symbols and verbal symbols can differ from one student to another depending on the cognitive style they have. Cognitive styles related to differences in receiving information visually and verbally are visualizer and verbalizer cognitive styles. Someone with a visualizer cognitive style tends to be easier to receive, process, store, and use information in the form of images. Whereas someone with a cognitive verbalizer style tends to be easier to receive, process, store, and use information in the form of text or writing. Of course this will affect the strategies used in solving mathematical problems, including those related to geometric problems.

Subjects with a cognitive verbalizer style tend to be easier to receive and convey information in words. As for subjects with visualizer abilities, it is easier to receive and convey information with pictures. (McEwan, 2007). Visualizer individuals like things in the form of pictures, diagrams, tables and graphs, because they are easier to understand than explanations using words for the same subject. Meanwhile, verbaliser individuals prefer to write, according to their habits which make it easier to understand information in the form of spoken or written (related to text).

The important thing related to the process of entering information into the sensory register is attention. In the learning process in the classroom, what the teacher explains is easy for certain students to understand, but it may be difficult for other students to understand. So the teacher needs to know the difficulties faced by students in solving problems so that this is related to their cognitive style. Based on the explanation above, the authors are interested in trying to explore the difficulties experienced by prospective mathematics teacher students in transformation geometry courses in terms of visualizer verbalizer cognitive style.

Research Methods

This research is a descriptive research with a qualitative approach. Qualitative research uses various types of data communication which are actually based on the honesty of the informants' answers as data (Kristina, 2020).

Qualitative methods rely on text and image data, have unique steps in data analysis, and use a variety of designs. So that researchers who in this case as writers need to record data, analyze information through several steps of analysis, and mention approaches to document the integrity or accuracy of the methodology and the validity of the data collected (Creswell, 2014: 292)

This research was conducted at Madura University in the even semester of the 2022/2023 academic year in May 2023. The subjects of this study were 2 students, each of whom had a cognitive visualizer and verbalizer style and had moderate mathematical abilities with the same type of error in each given item. The reason for choosing the 2 subjects was to present their respective difficulties in solving the given transformation geometry problem as well as a comparison between the two subjects.

The research instrument consists of main and supporting instruments. The main instrument is the researcher herself, while the supporting instruments include: a) visualizer and verbalizer cognitive style questionnaire (VVQ) b) Tes questions of transformation geometry, consists of 3 question c) Interview guide. To identify the cognitive styles of visualizer students and verbalizer students, the researcher adapted Mendelson's (2004) questionnaire, namely Visualizer and Verbalizer Questions (VVQ). This instrument consists of 20 statement items that lead to visualiser and verbaliser cognitive styles. Each student was asked to choose statements according to their respective characteristics.

Data collection techniques carried out are : 1). Cognitive style test, this test is given to determine prospective research subjects, this test was carried out using a cognitive style questionnaire to classify students in the visualizer or verbalizer cognitive style. 2) Transformation geometry test questions, to find out how students answer the given questions including the types of errors that arise. 3) Analysis of the selection of subjects who meet the criteria as research subjects. 4) Interviews regarding the results of student work regarding the types of difficulties faced by the subject.

The data analysis techniques used in this study were: a) data reduction, simplify data so that it fits the needs, namely to obtain information about the difficulties faced by subjects in transformation geometry courses b) data presentation, the process of presenting data is needed in qualitative data analysis to be able to present or display data neatly, systematically, arranged with certain relationship patterns (Zayyadi and Kurniati, 2018) , organized, c) drawing conclusions, these conclusions are obtained after the data obtained is studied in depth.

Results and Discussion

Results

In the following, the results of the research and discussion regarding the difficulties faced by the subject with the visualizer cognitive style, in this case referred to as S1, and the subject with the cognitive verbalizer style (S2) in solving transformation geometry questions on the concept of transformation mapping as many as 3 questions as follows:

1. Interpret and Visualize the Definition of a Transformation

From the question given the definition of transformation that the result of the transformation is the midpoint of a perpendicular segment from the origin to a line, like the following problem:

Let s be a line, W_s a transformation defined for all points C holds :

a. If $C \epsilon s$, then $W_s(C) = C$

b. If $C \notin s$, then $W_s(C)$ is the midpoint of the perpendicular segment from point C to s

If $s = \{(x, y) | x = 3\}$. Define coordinate of $W_s(C)$ for (4,2) !

Figure 1 : Test Question Number 1

In the question above the definition of transformation given is quite clear, but both S1 and S2 still have difficulty interpreting the definition.

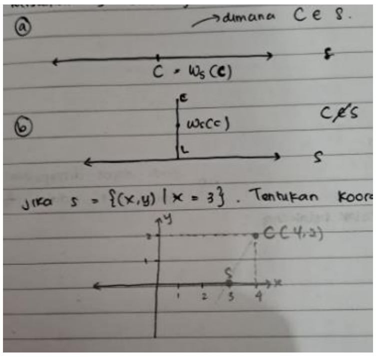

Figure 2. S1's Answer on Question Number 1

Based on S1's answers, the subject can illustrate points (a) and (b) correctly. This can be seen from figure (b), where point C has appeared and the results of the transformation of point C are correct. However, when the line S is determined by an equation, S1 is still confused about determining the line S or the transformation result of point C. It can be seen in figure 2 above. The concept of Cartesian coordinates plays a very important role in this case, where the midpoint should be sought from the abscissa and ordinate positions. According to Subject's confession, it was difficult for S1 to understand the languages used in the transformation and in this transformation geometry course. Students who are unable to interpret the definition of mapping into points and lines do not have good initial skills regarding basic geometry (Maifa, 2020).

"I have difficulty digesting the sentences in the transformation geometry book Ma'am, not to mention the symbols, the language of the theorems given is also difficult to understand." Not understanding the language of the questions, is the conclusion of the difficulties experienced by S1. Sometimes students feel afraid to understand a mathematical sentence. The reason is, they are lazy to read sentences containing symbols and sometimes it is difficult to read the symbols spoken.

Next regarding S2's answer to question number 1, the subject could describe points (a) and (b) separately, but when asked to determine the coordinates of the transformation result of the question asked, they still could not answer correctly.

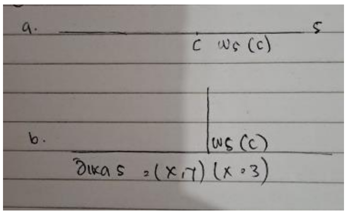

Figure 3. S2's Answer to Question Number 1

S2 can describe points (a) and (b), but at point (b) S2 has not been able to determine an origin, namely point C as stated in the problem and also determine the results of the mapping from point C precisely. The key word that must be understood here is "midpoint of the perpendicular segment". From the results of interviews with S2, it was found that the subject was able to define what the midpoint was and illustrate what the midpoint was like. However, the subject was confused when he got the sentence "midpoint of the perpendicular segment", the subject could not describe it. Furthermore, Subject was confused when he had to take point C (4,2). From his confession, the subject experienced difficulty in understanding the given transformation definition sentence, so he was confused in describing it. draw the line S as requested in the problem. Even though what is being asked in the problem is If s={(x,y)|x=3}, the subject is confused in understanding the symbol which states that the line S is a line on the coordinate axis where X= 3, so it fails to provide the line S meant literally appropriate. while verbalizing students were a little slower in finding strategies in solving problems using image (Indahwati, 2022)

2. Proving a Transformation

To prove that a mapping is a transformation requires an understanding of the surjective and injective functions. By using very simple language, where the surjective function is a mapping where each codomain must have a premap and may have more than one premap, while in the injective function, each codomain may not have a premap but if it has a premap it must be single. In other words, the concept of one-to-one correspondence must really be understood by students. Geometry transformations are one-to-one and onto functions from a set of points in the Euclidean plane to the same set (Budiarto, 2021).

In fact, S1 and S2 still cannot answer or prove whether a mapping includes transformation.

Known $T : V \rightarrow V$, defined as follows : if $P(x, y)$, then
$T(P) = (x + 1, y)$, for $x \geq 0$
$T(P) = (x - 1, y)$, for $x < 0$

Figure 4 : Test Question Number 2

For S1, the written answer that the subject gave was as shown below. When faced with a question of proof regarding transformation, students did not understand from which direction to prove it, whether from a member of the domain or codomain, and took two points as a reference to prove it.

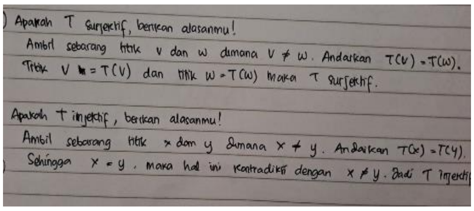

Figure 5. S1's Answer on Question Number 2

The subject described taking two points but did not explain the reason for taking the two points, even when asked what the description looked like when it was described, the subject admitted that he could not describe it. confused and even lazy to try to describe the statements in the problem and determine the origin and results of the transformation

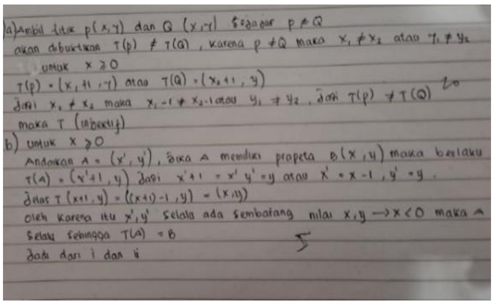

Figure 6. S2's Answer on Question Number 2

At first glance, the students' answers seem to be just memorizing without being able to describe the direction of proof that the mapping in question is surjective or injective. Subjects were able to express surjective and injective definitions, but when given the mapping form of the questions, they had difficulty in stringing words and interpreting what the mapping form of each pre-map map looked like, when it was related to the surjective-injective definition. Even at the time of the interview, the subject had not been able to express the intent of the subject's answer regarding the flow of proof that the subject had written and concluded that the function was both subjective and injective. When the subject was asked to describe in the form of an image, S2 was still confused. The subject cannot describe it because they are still confused in understanding the form of the transformation and the direction of the proof.

From this, it appears that indeed both S1 and S2 for Mastery of basic geometric concepts are still relatively lacking. Concepts related to line equations, determining coordinate points and of course describing a certain line equation need to be mastered by students before entering transformation geometry. This is in line with the opinion of Sulistiowati, (2021) which reveals that the factors that cause students to experience difficulties in solving geometric problems consist of internal and external factors. Internal factors come from within the students, including inaccuracy, lack of understanding of mathematical concepts related to problems, and students' geometric skills. While factors. Internal comes from outside the student's self, namely from the educator and the learning process carried out

3. Determine the Area of Origin and the Result Area of a Mapping

Before taking the Transformation geometry course, students must take Euclidean geometry and analytical geometry courses. The course is of course continuous and supports the mastery of transformation geometry. Even at school, the geometry material in lectures is actually given at a glance, so if basic geometry has not been well mastered, of course it will affect the geometry material at the next level. The third question relates to the circle concept. S1 is able to illustrate the equation of the circle given in the problem into the illustration of the circle in question as shown in the picture below :

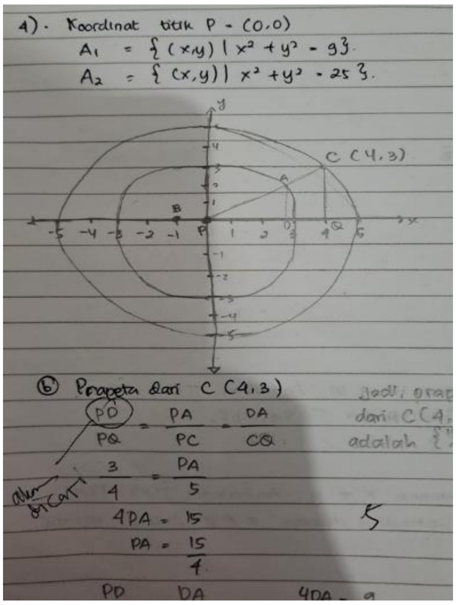

Figure 7. S1's Answer on Question Number 3

From the problem known circle :
$A_1 = \{(x, y)|x^2 + y^2 = 9\}$
$A_2 = \{(x, y)|x^2 + y^2 = 25\}$

S1's answer already represents the two circle equations asked for in the question, but to determine the position or coordinates of point A as in the subject's answer is wrong. S2 still can't figure out the position of the abscissa of point A which is actually not at X=3. The position still has to be sought through a comparison of the corresponding sides.

From the problem, it is known that $T : A_1 \to A_2$ is an equivalent which is defined as follows: If $X \in A_1$ then $T(X) = X' = \overleftrightarrow{PX} \cap A_2$, reasoning in geometry is often an obstacle for students, especially those related to geometric shape image. For S2, who is a Verbaliser subject, it is easier to understand information in the form of words to visualize it. However, the subject admitted that he had not been able to visualize the information on the questions due to confusion in understanding the symbols and sentences from the definition of the questions so that the subjects did not provide answers on the answer sheet. From this it is revealed that the concept of circular equations has not been mastered by S2. Students still experience procedural errors in solving transformation geometry problems, due to the inability of students to determine the steps to solve a given transformation geometry problem (Adibah, 2022).

From the explanation above, it can be revealed that both S1 and S2 experience the following difficulties (1). Difficulties in understanding the concept of transformation which includes surjective and injective functions (2) difficulties in interpreting mapping into visualization in the form of images (3) Lack of understanding of basic geometric concepts (4) Weak reasoning power (5) difficulties in mathematical operations. S1, in this case the subject with the visualizer cognitive style, should more easily convey information in the form of images, but due to constraints on the reasoning of sentences and symbols in the questions, S1 has difficulty conveying information which in this case illustrates images. For S2 as a Subject with the Verbaliser cognitive style, it is actually easier to understand information in the form of writing, constrained by the language and symbols listed in the questions, so that the ability to understand information is constrained as a result it is increasingly difficult to convey information in the form of images. difficulties experienced by students in solving geometric problems include (1) students having difficulty in using concepts, (2) students having difficulties in using principles, and (3) students having difficulties in solving verbal problems, (Fauzi, 2020). The visualizer student is able to understand the information in the problem even though previously the student has to read repeatedly until he understands to understand the information on the problem presented in verbal form or words while the verbalizer student tends to have the ability to hear, so that he has the habit of receiving and obtaining information in text form (Novitasari, 2019).

Conclusion

Based on the results and discussion of the research above, it can be concluded that the difficulties of students with cognitive visualizer and verbalizer styles in transformation geometry tend to be the same. After analyzing the difficulties of the two subjects include (1) Difficulty in visualizing the definition of a transformation (2) Difficulty in proving whether a mapping is a transformation (3) Difficulty in determining the area of origin and the result area of a mapping. The Visualizer subject answers the three questions given and tries to describe the definition or illustration given by the questions, although they still cannot describe it precisely, but it is better than the subject verbalizer. Verbalizer subjects, who are essentially easier to process information in the form of writing, are constrained by the arrangement of mathematical sentences and mathematical symbols which make the subject reluctant to try to answer questions.

From the results of the analysis it was also revealed that the causes of the subject's difficulties were influenced by several aspects, namely, lack of mastery of basic geometric concepts, weak reasoning power and difficulties in mathematical operations. This has given impetus to the Mathematics Education Study Program at the University of Madura in particular and the world of mathematics education in general to pay more attention and further strengthen the basic concepts of mathematics which in this case are related to basic geometry at the school level.

References

Adibah, Fanny. (2022). Analisis Kesalahan Mahasiswa dalam Memecahkan Masalah Geometri Transformasi. *Widya Loka, 9*(2). 194-204.

Aini, S. D., Zayyadi, M., & Saleh, K. A. (2020). Written mathematical communication skills on open-ended problems: is it different based on the level of mathematics ability?. *MaPan: Jurnal matematika dan Pembelajaran,* 8*(2), 179-204.*

Budiarto, M. T. dkk. (2021). *Geometri Transformasi.* Yogyakarta: Pustaka Pranata.

Creswell, J.W. (2014). *Research Design. Qualitative, Quantitative and Mixed Method Approaches*. Forth Edition. California.

Fauzi, Irfan & Andika A. (2020). Analisis Kesulitan Belajar Siswa pada Materi Geometri di Sekolah Dasar. *Kreano, 11*(1). 27-35.

Hanafi, M., Wulandari, K. N., & Wulansari, R. 2017. Transformasi Geometri Rotasi Berbantuan Software Geogebra. *FIBONACCI: Jurnal Pendidikan Matematika dan Matematika, 3*(2). 93-102.

Indahwati, R & Fetty Nuritasari. (2022) Student's Ability In Explaining The Concept Of Solid Figure's Volume Reviewed From Visualizer Verbalizer Cognitive Style. *JME (Journal of Mathematics Education), 7*(1). 36-45.

Kristina, Anita. (2020). *Belajar Mudah Metodologi Penenlitian Kualitatif.* Jakarta: Rumah Media.

Maifa, S.T. (2019). Analisis Kesalahan Mahasiswa dalam Pembuktian Transformasi Geometri *JRPIPM, Jurnal Riset Pendidikan dan Inovasi Pembelajaran Matematika*, *3*(1). 8-14.

McEwan, R. C., Reynolds, S. (2007). Verbaliser and Visualiser: Cognitive Styles Are Less than Equal. *Journal of Communication, 54*(3). 474-491.

Mendelson, Andrew L. (2004). For Whom is a Picture Worth a Thousand Words? Effects of the Visualizing Cognitive Style and Attention on Processing of News Photos. *Journal of Visual Literacy, 24*(1). 85-106.

Novita, R., Prahmana, R. C. I., Fajri, N., & Putra, M. (2018). Penyebab kesulitan belajar geometri dimensi tiga. *Jurnal Riset Pendidikan Matematika*, *5*(1). 18-29.

Novitasari, D., Pujiastuti, H., & Sudiana, R. (2021). Kemampuan Berpikir

Tingkat Tinggi ditinjau dari Gaya Kognitif Visualizer dan Verbalizer Siswa dalam Menyelesaikan Soal Matematika. Jurnal Cendekia: Jurnal Pendidikan Matematika, *5*(2). 1476-1487.

Subekti, F.E., & Kusuma, A.B. (2015). Efektivitas Problem Based Learning Berbantuan Software Geogebra pada Geomteri Transformasi. *Seminar Nasional Matematika dan Pendidikan Matematika UNY*.

Sulistiowati, D.L. (2021). Faktor Penyebab Kesulitan Siswa dalam Memecahkan Masalah Geometri Materi Bangun Datar *BULLET : Jurnal Multidisiplin Ilmu*,*1*(5). 941-951.

Sundawana, M. D., dkk. (2018). Kajian Kesulitan Belajar Mahasiswa dalam Kemampuan Pembuktian Matematis ditinjau dari Aspek Epistemologi pada Mata Kuliah Geometri Transformasi. *INSPIRAMATIKA, Jurnal Inovasi Pendidikan dan Pembelajaran Matematika*, *4*(1). 13-21.

Supardi, L. (2021). Commognitive analysis of students' errors in solving high order thinking skills problems. *Turkish Journal of Computer and Mathematics Education (TURCOMAT)*, *12*(6), 950-961.

Zayyadi, M., & Kurniati, D. (2018). Mathematics reasoning and proving of students in generalizing the pattern. *International Journal of Engineering & Technology*, *7*(2), 15-17.