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Abilities and Difficulties of Ninth-Grade Students in Solving Geometry Transformation Problems

Tasya Aprilla Trisna, M Ikhsan, & Elizar Elizar

Department of Mathematics Education, Universitas Syiah Kuala, Indonesia

Abstract: Geometry is one of the challenging subjects for students. This study aimed to determine the ability of students to solve geometric transformation problems, the difficulties they experienced, and the causes. This research employed a mixed method with a sequential explanatory design. Eight Year 9 students were the subjects of this study. Data were collected through tests and interviews. The data were analyzed quantitatively, followed by qualitative analysis involving reducing data, presenting data, and concluding. The results indicated that the student's ability to solve geometric transformation problems was moderate. Students found it difficult to solve geometric transformation problems. The student's difficulties included determining the translation when a starting point and an image point were given and determining the image of a point/curve by a transformation. Students had not fully mastered the schemes in the geometric transformation, were not proficient in using formulas, and were not precise in their calculations.

Keywords: students' difficulty, transformation, translation, rotation, dilatation.

Abstrak: *Geometri adalah salah satu topik yang sulit bagi siswa. Tujuan penelitian ini yaitu mengetahui kemampuan siswa dalam menyelesaikan soal transformasi geometri dan kesulitan yang dialami oleh siswa serta penyebab terjadinya kesulitan dalam menyelesaikan soal transformasi geometri. Penelitian menggunakan pendekatan Mixed Method dengan jenis explanatory sequential. Subjek penelitian ini adalah 8 siswa kelas IX. Teknik pengumpulan data yaitu tes dan wawancara. Data dianalisa secara kuantitatif, kemudian kualitatif dengan mereduksi data, menyajikan data, dan menarik kesimpulan. Hasil penelitian mengindikasikan kemampuan siswa dalam menyelesaikan soal transformasi geometri tergolong kategori sedang. Hal ini mengindikasikan siswa masih sulit dalam menyelesaikan soal transformasi geometri. Adapun kesulitan siswa yaitu menentukan translasi jika diberikan sebuah titik awal dan titik bayangan, menentukan bayangan suatu titik/kurva oleh suatu transformasi. Penyebabnya yaitu siswa belum sepenuhnya menguasai skema yang ada di dalam transformasi geometri, tidak mahir menggunakan rumus, dan tidak tepat perhitungannya.*

Kata kunci: *kesulitan, geometri, translasi, rotasi, dilatasi*

▪ INTRODUCTION

Law No. 20 of 2003 of the Republic of Indonesia concerning the National Education System Article 37 Paragraph (1) confirms "Mathematics is one of the compulsory subjects for elementary and middle school students." The goal of learning mathematics at MTs/SMP (Junior High School level) is that students can master mathematical schemes, describe the relationships between schemes, and run the schemes as algorithms in a flexible, practical, and thorough way to solve problems. Mathematics is a learning that has consistency and structure (Suherman, 2003). Mathematical cognition is organized hierarchically, structurally, rationally, and systematically, from the simplest to the most complex schemes.

Elizar Elizar
*Email: elizar@unsyiah.ac.id

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Geometry links various materials in mathematics (Maulani & Zanthy, 2020). Geometry plays an important role in everyday life, so it must be understood and mastered by students (Luneta, 2015). However, students in Indonesia still view geometry as difficult (Alghadari et al., 2020). Students need mature concepts to implement geometric skills such as visualizing, describing, sketching, and labeling certain points. Students who study geometry can associate abstract mathematics with concrete mathematics. This can be a stimulus for a more thorough student interpretation. In line with the opinion of Septyawan et al. (2019), students need to understand concepts because understanding concepts is closely related to mathematical reasoning. Students must have a conceptual understanding of mathematics to understand mathematics more deeply (Andamon & Tan, 2018).

Based on data from the Ministry of Education and Culture (Kemendikbud) in 2018, the average score for the National Mathematics Examination is the lowest among other subjects, such as English, Indonesian, and Sciences. Data for the 2018/2019 school year shows that the average score at the junior high school level (SMP) is 46.56, while at MTs (Islamic junior high school level), it is 42.24. In 2017/2018, the average score for the National Examination also showed that mathematics was the subject with the lowest score, with the average achievement for SMP being 44.05, while in MTs, it was 41.16. In addition to these data, there is error analysis data from the average student's answers. Most of the students made mistakes in answering geometry questions. This can be seen from the 2018 data from the Ministry of Education and Culture (Kemendikbud) regarding the percentage of students who answered correctly in the National Examination; the percentage of students who answered correctly in geometry and measurement was 41.40 and the lowest percentage. Others include algebra, namely 41.88; numbers, 44.99; and statistics and opportunities, namely 45.71 (Ministry of Education and Culture, 2018).

Many experts and previous research have discussed the importance of understanding concepts in studying mathematics (Bisson et al., 2016; Russell et al., 2020). An insufficiently deep understanding of a material makes it difficult for students to solve problems (Hardiyanti, 2016). The difficulties students face when learning mathematics are because they do not form their knowledge of mathematical concepts but take the knowledge given by the teacher directly and memorize it without knowing the implications of these terms.

Geometry transformation is one of topics in geometry at junior high school level. The subject matter of transformation is useful for developing spatial abilities, analytical thinking skills, and improving mathematical proof. This ability encourages students to further explore mathematical concepts to solve mathematical problems precisely and accurately (Kribbs & Rogowsky, 2016).

Previous researchers have conducted research on students' understanding and geometric abilities. Among them are DeJarnette & González (2016), who analyze students' abilities to solve geometry problems in everyday life, and Cirillo & Hummer (2021), who examine students' abilities and behavior in solving problems related to proving geometry. Furthermore, Sulistiowati et al. (2019) examined students' difficulties in geometry based on the theory of van Hiele and Aini et al. (2020), identifying the level of students' creative thinking in visual-spatial geometry.

However, most previous studies discussed geometry in general and assessed students' abilities. In connection with students' difficulties in solving mathematical problems, it is necessary to review students' mistakes in solving problems to examine what students experience when studying mathematics, especially geometric transformations. This study discusses students' abilities in geometry, specifically related to students' abilities and difficulties in translation, reflection, and rotation.

▪ METHOD

Participants

Subjects were selected by purposive sampling method. This method takes the subject with certain considerations. The subjects of this study were 9th-grade students from a junior high school in Banda Aceh, Indonesia. The selection of subjects for interviews was based on test results regarding geometric transformation as seen from the criteria of students making mistakes when answering the test, each consisting of two students representing sub-transformation of geometry, namely translation, reflection, rotation, and dilation.

Research Design

This study employed the mixed method approach. This method combines quantitative data with qualitative data (Creswell, 2012). This study applied an explanatory sequential design, namely a mixed method that collects quantitative data in the first stage to interpret the first problem, namely how students' abilities in solving geometric transformation problems. Next, in the second stage, qualitative data collection was obtained based on initial quantitative results to answer the second and third research problem: what difficulties students face when solving geometric transformation problems and their causes.

Instrument

The instruments in this study consisted of the test and interview guides. The test was used to determine students' abilities in solving geometry transformation questions and the difficulties students experiencing in solving geometric transformation questions. The test given to students have been validated by one expert lecturer in geometry and one math teacher. The test consists of eight questions (two translation questions, two reflection questions, two rotation questions, and two dilation questions). The test items were adopted from the National Examination (UN) questions, the 2018 mathematics package book for Year 9, and the accompanying math textbook for Year 9 students. Interview guidelines in this study will be a reference for researchers in interviewing students and teachers. The interview guidelines for students refer to student answer sheets.

Data Collection and Analysis

Data collection in this study involved a test and interviews. The test used in this study consisted of problems related to geometry transformation for Year 9 to measure students' abilities and the difficulties students experiencing in solving questions about geometric transformations. The test assessment results used to determine students' ability to understand geometric transformation material and where students' mistakes were in solving geometric transformation problems. The type of test used in this study

was a written test, consisting of eight long answer questions.

The type of interview used was semi-structured, namely preparing questions to investigate the difficulties experienced by students in solving geometric transformation problems and the factors causing these difficulties. Interviews were conducted with eight students (two students who made mistakes on translation questions, two students who made mistakes on reflection questions, two students who made mistakes on rotation questions, and two students who made mistakes on dilation questions), and this interview will also be conducted on the Year 9 mathematics teacher.

Testing the credibility of the data was done through data triangulation, in particular source triangulation. The researchers checks the validity of the data by comparing and checking the results of interviews from two sources, namely teachers and students (Sugiyono, 2015).

Data were analyzed using two techniques: quantitative data analysis and qualitative data analysis. In the quantitative data analysis technique, a test was used to measure students' ability to solve geometric transformation problems. The ability to solve problems can be seen from the scores obtained by students after the test. To calculate student scores, student test answers were analyzed, and scores were determined according to the scoring rubric and answer key, and the average was calculated.

The total average score obtained was then grouped according to the criteria for problem-solving abilities as follows.

Table 1. Categories of student ability levels (Sudijono, 2009)

Categories	Score
Excellent	$X > M + 1.5SD$
Good	$M + 0.5SD < X \leq M + 1.5SD$
Average	$M - 0.5SD < X \leq M + 0.5SD$
Fair	$M - 1.5SD < X \leq M - 0.5SD$
Poor	$X < M - 1.5SD$

where X, M, and SD are the score, mean, and standard deviation, respectively. Next, qualitative data analysis techniques were performed using data analysis techniques Miles & Huberman (2007). Qualitative data analysis comprised data reduction, data presentation, and drawing conclusions. The data reduction stage was analyzing the steps taken by students in answering geometric transformation questions according to the assessment rubric and answer key. Interviews were conducted with the selected subjects to examine the difficulties experienced by students and the factors of these difficulties. The data presentation stage was carried out by presenting the reduced data by describing the data that has been processed into a descriptive text. It explained students' difficulties in solving geometric transformation problems, and data from student and teacher interviews was to find out the factors causing students' difficulties in solving geometric transformation questions. Finally, the conclusion was drawn based on the results of the data obtained both from the initial data and the descriptive text.

▪ RESULT AND DISCUSSION

This research was carried out in two stages: distributing questions to 25 Year 9 students and interviewing eight selected students. The determination of student ability category indicators was based on an average score of students' abilities in the geometric transformation and the standard deviation. It was obtained that the average student score was 34 (SD=16). Based on the mean and standard deviation, the student's ability category in geometric transformation material is presented in Figure 1.

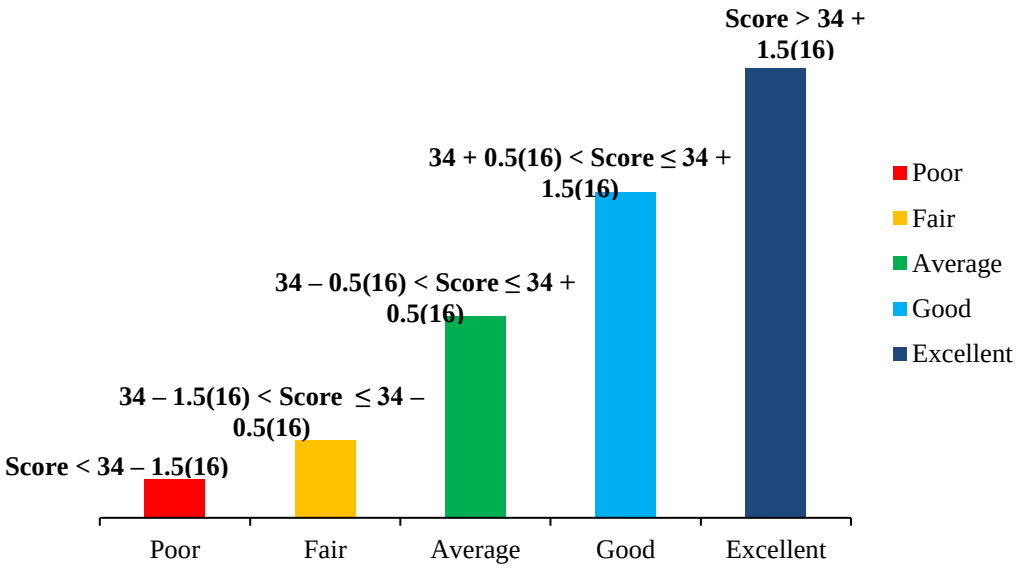


Figure 1. The indicators of student ability category

Based on the test of geometry transformation, in general, it was found that the students' grade was not satisfactory because most were incorrect in answering. The minimum score was 20 (20%), the maximum score was 94 (94%), and the average score is 34 (34%). Only 1 out of 25 students (0.04%) scored very high, 5 out of 25 students (0.2%) scored high, 11 out of 25 students (0.44%) scored medium, and 8 out of 25 students (0.32%) scored low.

From the category of student ability levels described by Sudijono (2009) in the previous section, if students answer correctly, with an average of 58% of all questions, students can be said to have no difficulty solving geometric transformation questions. It is known that only 0.04% of students did not face difficulties in geometric transformation. This means that students who faced difficulties when solving geometric transformation problems <58%. So, it can be concluded that Year 9 students in this study experienced difficulties solving geometric transformation problems.

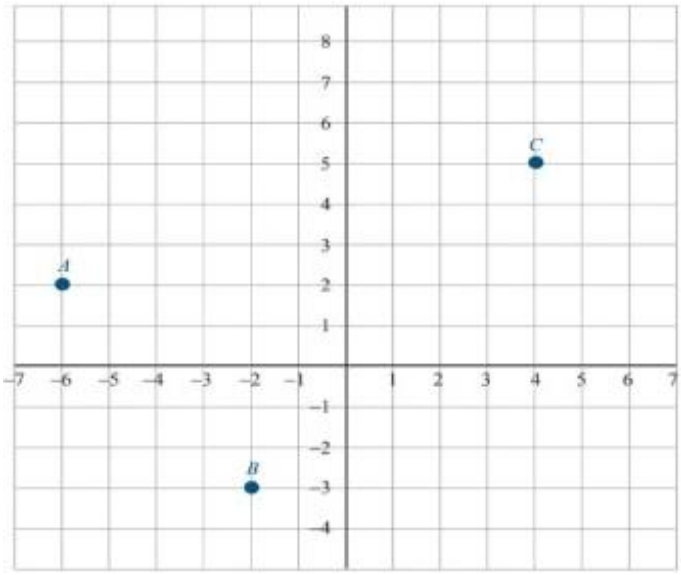
Based on the test results, the total score of students on the translation sub-material was 340, with an average of 13.6 (13.6%), the total score of all students on reflection was 268, with an average of 10.72 (10.72%), the total score of all students on the rotation was 150, with an average of 6 (6%), and the total score of all students on the dilation was 117, with an average of 4.68 (4.68%). Based on the acquisition of the total score and average of each sub-material, it can be seen that the translation sub-material

has the highest total score and average. Hence, it could be concluded that, for the translation material, many students could answer the problem but were incorrect. The dilatation had the lowest scores and average, in particular many students did not answer questions number 7 and 8. So, it can be concluded that the dilatation was the most difficult problem for students compared to other transformation questions.

Analysis of Students' Difficulties in Solving Geometry Transformation Problems

A. Students' Difficulties in Solving Translation Problems and Their Causes

Problem number 1: A tiger is hunting a deer in the forest. Based on the monitoring results, it is known that the coordinates of the deer are at point A, and the coordinates of the tiger are at point B. The deer then moves towards point C.



a. Determine the pair of translation numbers that move the deer from point A to point C!
b. If the tiger uses the same translation as the deer does, will the tiger be able to catch the deer?
c. Determine the pair of translation numbers that must be made by the tiger so that he gets a deer!

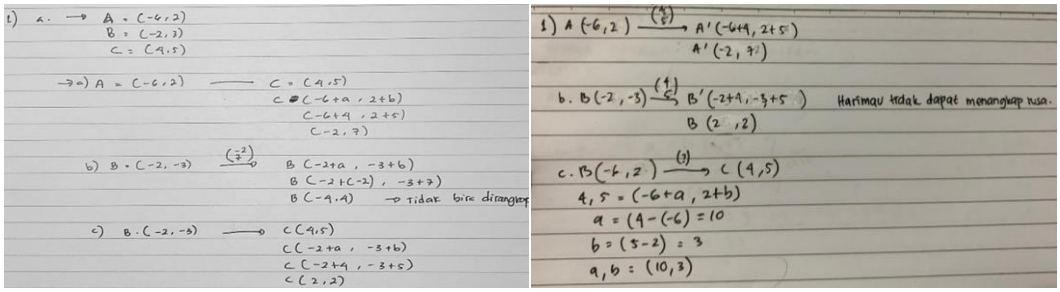


Figure 2. Answer S_{24} and S_{21} on Problem 1

Figure 2 shows subject S24 did not understand the problem because S24 was wrong in identifying the value of the translation when given a starting point and shadow point, as shown in answers 1a and 1b. S24 also made errors in deducing information from the images provided. S24 created the coordinates of B(-6,2), which should be B(-2,-3). Furthermore, S24 could not use the translation formula correctly, marked by the subject incorrectly applying the formula to questions 1a and 1b; coordinate (4,5) should be the coordinate C after moving from point B, not the value of the translation pair T(a, b). So, it can be concluded that subject S24 did not understand the translation well. In addition, based on the interviews, it was found that the factors causing students' difficulties in solving translation problems were students not skilled in using translation formulas in solving problems. In addition, other factors causing students to experience difficulties in solving translation problems were the accuracy of students in solving problems was also low. In addition, the lack of student skills in solving these problems or the like causes students to be unfamiliar and experience difficulties when working on problems. However, students in this study understood that translation requires direction and magnitude, as found in previous studies (Yanik, 2014).

Based on the answer sheet (Figure 2), subject S21 did not understand the problem because S21 was wrong in identifying the value of the translation when given a starting point and an image point, as seen in answers 1a and 1c. Furthermore, S21 cannot use the translation formula correctly, as seen in answers 1a and 1c. Subject S21 used the translation formula incorrectly; coordinates (4,5) should be the coordinates of point C, not a pair of translations T(a,b). Based on this explanation, it is suspected that subject S21 did not understand the translation well, so the subject could not use formulas properly. Based on the interviews, it was found that the factors causing students to experience difficulty in solving translation problems mathematically were students who were not skilled in using the translation formula in solving problems. In addition, another factor that causes students to experience difficulties in solving geometric transformation problems in the sub-translation material is the lack of students' skills in solving problems so students are not accustomed to working on similar translation problems, which results in students not being able to use the translation formula correctly.

It can be concluded that students' challenges in translation material are difficulties when determining a translation when given a starting point and an image point. The factors causing student difficulties are the students' unskilled use of the translation formula when solving problems, the low skills of students when solving similar problems, and the lack accuracy of students in understanding and solving translation problems. This is in line with Maulani & Zanthy's research (2020), namely that students experience difficulties in solving translation problems; they do not understand translation material and are incorrect in using and applying translation formulas.

B. Students' Difficulties in Solving Reflection Problems and Their Causes

Problem number 3: Triangle ABC is reflected on the x-axis, then the y-axis, then the origin. The reflection results are coordinated at A'"(2, 3), B'"(8, -4), and C'"(-6, -7). Determine the coordinates of A, B, and C!

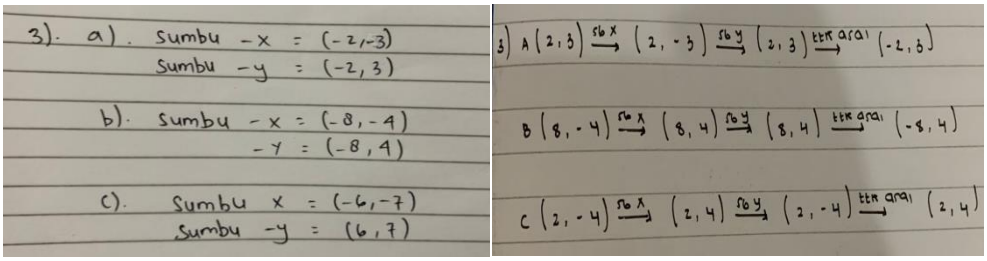


Figure 3. Answer S_{11} and S_6 on Problem 3

Based on the S11 (Figure 3), subject S11 made a mistake in the completion steps, S11 looked for coordinates A, B, and C, starting from a reflection on the x-axis followed by reflection on the y-axis, which should start from reflection on the origin O(0,0) followed by reflection on the y-axis and finally a reflection on the x-axis. This resulted in S11 incorrectly changing the coordinates of the results of three reflections to the initial coordinates. S11 used the reflection formula incorrectly on the x-axis, as shown in the answer sheet. The initial coordinates before being reflected are A(-2,-3), B(-8,-4), and C(-6,7); the initial coordinates should be A(2,3), B(8,-4), and C(-6,-7). S11 also incorrectly used the reflection formula on the y-axis, as seen in the answer sheet. S11 made the coordinates of the result of one reflection a time A'(-2.3), B'(-8.4), and C'(6,7) the coordinates of the result of one reflection should be A'(2,-3), B'(8,4), and C'(-6,7). Furthermore, S11 made no solutions to the origin O(0,0). So, it can be concluded that S11 did not understand the basic concept of reflection and did not understand the questions correctly.

Based on the interviews, it can be concluded that the factors that cause students' difficulties in solving reflection questions are not knowing the basic concepts of reflection and not knowing the characteristics of reflection. Other factors causing students to experience difficulties in solving reflection questions are the lack accuracy of students in solving problems. In addition, learning is less effective without teaching aids/other learning media (as found in the interview) that can help students understand reflection. The lack of student skills in solving problems also causes students to be unfamiliar and experience difficulties when working on the questions.

Based on the answer sheet (Figure 3), subject S6 was not careful in understanding the problem because he was incorrect in identifying the coordinates of point C, as seen in the answer sheet. Point C is C(2,-4), which should be the coordinates of point C(-6,-7). Furthermore, the steps performed by the S6 were wrong. S6 looked for coordinates A, B, and C, starting from a reflection on the x-axis followed by a reflection on the y-axis, which should start from a reflection on the origin O(0,0), followed by a reflection on the y-axis and finally a reflection on the x-axis. This resulted in S11 incorrectly changing the coordinates of the results of three reflections to the initial coordinates. Furthermore, S6 incorrectly used the reflection formula on the x-axis, as shown in the answer sheet, the initial coordinates before being reflected are A(2,-3), B(8,-4), and C(2,-4) which should be the initial coordinates are A(2,3), B(8,-4), and C(-6,-7). Furthermore, S6 incorrectly used the reflection formula on the y-axis, as shown in the answer sheet. S6 made the coordinates of the result of once reflection A'(2,3), B'(8,4), and C'(2,- 4); the coordinates of the result of one reflection should be A'(2,-3), B'(8,4), and C'(-6,7). S6

was also wrong in using the reflection formula for the origin O(0,0), as shown in the answer sheet. The coordinates of the result of the two reflections were A"(-2,3), B"(-8,4) , and C"(2,-4), which should coordinate the results of one reflection are A"(-2,-3), B"(-8,4), and C"(-6,7). S6 also incorrectly used the reflection formula. Based on this explanation, it is suspected that S6 did not understand the reflection material well, especially the basic concepts of reflection.

Based on the interviews, it can be concluded that the factors causing students' difficulties in solving reflection problems mathematically are not knowing the basic concepts of reflection and not knowing the properties of reflection. Another factor causing students to experience difficulties in solving geometric transformation problems in the reflection is that they are not used to solving similar reflection questions, causing students to experience difficulties when solving problems.

It can be concluded that the difficulties experienced by students in solving reflection problems are difficulties in determining the image of a point when it is reflected on the x-axis, y-axis, and the point of origin O(0,0) and errors in using the reflection formula on the x-axis, axis- y, and the origin is O(0,0). Based on the difficulties in solving these reflection problems, there are several causal factors, namely not understanding the basic concept of reflection on the x-axis, y-axis, and the point of origin O(0,0), not knowing the properties of reflection. As for other factors, namely students' skills in solving similar reflection questions are still low, and learning is less effective. This is in line with research by Seloraji & Eu (2017), which found that students' initial abilities in reflection were in the moderate category and students were not interested in learning geometry manually; the application of software such as GeoGebra can increase students' interest and ability in geometry, reflection.

C. Students' Difficulties in Solving Rotation Problems and Their Causes

Problem number 6: Quadrilateral PQRS has coordinates at P(2, -2), Q(4, -1), R(4, -3), and S(2, -4). Determine the image and draw the PQRS at a 90º rotation counterclockwise centered at the origin.

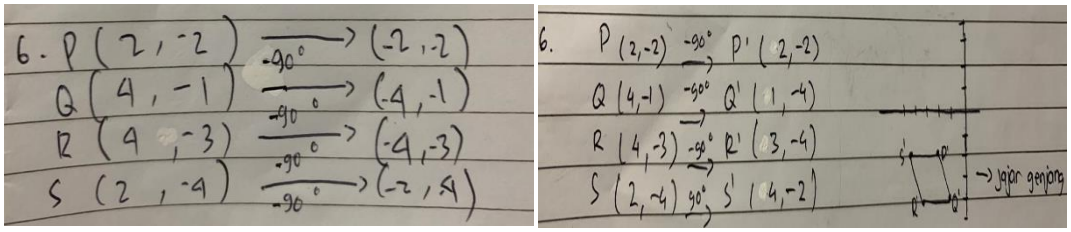


Figure 4. Answer S_{18} and S_{22} on Problem 3

Based on the answer sheet S18 (Figure 4), it can be seen that subject S18 made mistakes in using the rotation formula. S18 used the -90º rotation formula; the formula that should be used is the 90º rotation formula because the question clearly said 90º rotation counterclockwise. Based on this, it is suspected that S18 did not know the conditions of the direction of rotation which resulted in S18 being wrong in using the formula. The solution steps taken by S18 are correct, but because the formula used is wrong, the answer is wrong. S18 also does not create an image from the PQRS that has

been rotated 90º counterclockwise centered at the origin. Thus, it can be concluded that S18 does not understand the basic concept of rotation correctly.

Based on the interviews, it can be concluded that the factors causing students' difficulties in solving rotation problems mathematically are not knowing the basic concepts of rotation, the requirements for the direction of rotation, and not knowing the location of the quadrants. In addition, the factors causing students to experience difficulties in solving geometry transformation problems in rotation are the lack of students' talent and interest in mathematics. This is indicated by students not paying close attention to the material when the teacher explained it in front of the class, as is known in the teacher interview.

Based on the answer sheet (Figure 4), subject S22 incorrectly used the rotation formula. S22 used the -90º rotation formula; the formula that should be used is the 90º rotation formula because in the question, it is clear that it says 90º rotation counterclockwise. Based on this, it is suspected that S22 did not know the conditions of the direction of rotation, resulting in S22 being wrong in using the formula. In the completion step carried out by S22, it can be seen that the results obtained using the -90º rotation formula were also wrong. It is said that subject S22 also did not know the -90º rotation formula. In addition, S22 also did not create an image from the image of a PQRS rotated 90º counterclockwise centered at the origin. It can be concluded that S22 did not understand the concept of rotation, namely the requirements for the direction of rotation and the basic concept of the rotation formula.

Based on the interviews, it can be concluded that the factors causing students' difficulties in solving rotation problems mathematically are not knowing the basic concepts of rotation and the requirements for the direction of rotation. In addition, another factor causing students to experience difficulties in solving geometry transformation problems in the rotation sub-matter is that students are not used to solving similar reflection questions, leading to students to experience difficulties when solving problems.

It can be concluded that the difficulties experienced by students in solving rotation questions are difficulties in determining the image of a point when it is rotated 90º with conditions counterclockwise. This difficulty is caused by several factors, including not understanding the concept of rotation, such as the basic concept of the rotation formula and the conditions for rotating the direction of rotation and not knowing the location of the quadrants. As well as the lack of talent and student interest in learning mathematics. Rotation is not only difficult for junior high school students but also for university students. Research conducted by Ada & Kurtulus (2010) found that students who were the subject of the research also experienced difficulties in working on rotation questions; their errors include errors in formula application, procedural errors, and drawing errors.

D. Students' Difficulties in Solving Dilation Problems and Their Causes

Problem number 8: ABCD is a parallelogram with coordinates A(1, 2), B(7, 2), and C(10, 8). At a dilation with center O(0,0) and a scale factor k = -1/2, determine the coordinates of the image of point D!

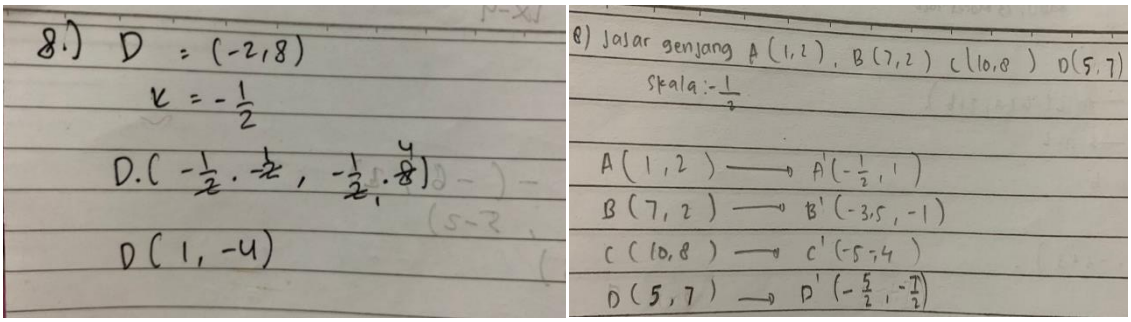


Figure 5. Answer S_{15} and S_{21} on Problem 8

Based on the answer sheet (Figure 5), subject S15 made mistakes at the completion step in finding the shadow point when given a starting point and a scale factor because he was wrong in determining the coordinates of point D. The coordinates of point D obtained by S15 were D(-2,8), instead it should be D(4,8). This causes the results of the coordinate dilatation of point D with a scale factor of k = -1/2 to be incorrect. So, it can be concluded that S15 was not solving the problem thoroughly.

The interviews reveal that the factors causing students' difficulties in solving dilation problems mathematically are being careless in the calculation process in finding dilation shadow points with a scale factor. In addition, another factor is a lack of understanding of the dilation. The results of teacher interviews reinforced that when the dilatation material was explained, most students did not listen and pay close attention to it, resulting in students having problems solving problems when given questions. Most of Year 9 students did not answer questions number 7 and number 8, which were about dilation.

Based on the answer sheet (Figure 5), subject S21 was wrong in writing the dilation formula, S21 made the dilation formula, namely (k+x and k+y), where the dilation formula should have been (kx, ky). S21 is also wrong at the completion step in finding the image point when given a starting point and a scale factor because it is incorrect in determining the coordinates of point D of a parallelogram. The coordinates of point D obtained by S21 was D(5,7), whereas the coordinates of point D should be D(4,8). This results in the coordinate dilatation of point D with the scale factor k = - being searched for incorrectly. So, it can be concluded that subject S21 did not understand the basic concept of dilation and was not careful in solving the problem. Based on the interviews, it can be concluded that the factors that cause students' difficulties in solving dilation problems are students not understanding the concept of dilation, mistakes in the calculation process, low aptitude, and students' interest in mathematics. It can be concluded that the difficulties experienced by students in solving dilation problems are their difficulties finding shadow points when given a starting point and a scale factor because they are wrong in determining the coordinates of point D of a parallelogram, and are wrong in making the dilation formula. There are several contributing factors, namely, not knowing the concept of dilation and not accurately calculating the dilation shadow point with a scale factor.

▪ CONCLUSION

Based on the discussion of the analysis results, the ability of Year 9 students in solving geometric transformation problems is in the medium category. This indicates that students still have difficulty solving geometric transformation problems. Students faced various difficulties when solving geometric transformation problems. One of them was the difficulty in determining a translation if given a starting point and an image point in reflection material. Also, the difficulty in determining the image of a point when it is reflected on the x-axis, y-axis, and the origin O(0, 0) and errors in using the reflection formula for the x-axis, y-axis, and origin O(0,0). In rotation, students have difficulty determining the image of a point when it is rotated 90º counterclockwise, and difficulty on dilation material, namely the difficulty in finding the shadow point when given a starting point and a scale factor because of errors in determining the coordinates of point D of a parallelogram, and mistakes in making the dilation formula. The factors that cause students to experience difficulties were that students who were not skilled in using the translation formula in solving problems, did not understand the basic concept of reflection on the x-axis, y-axis, and the point of origin O(0,0). They also did not know the properties of reflection and not understand the concept of rotation, such as the basic concept of the rotation formula and the conditions for rotation of the direction of rotation. Furthermore, they did not know the location of the quadrants and the concept of dilation, and were not careful in the calculation process in finding dilation shadow points with a scale factor.

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