BIG IDEA 38

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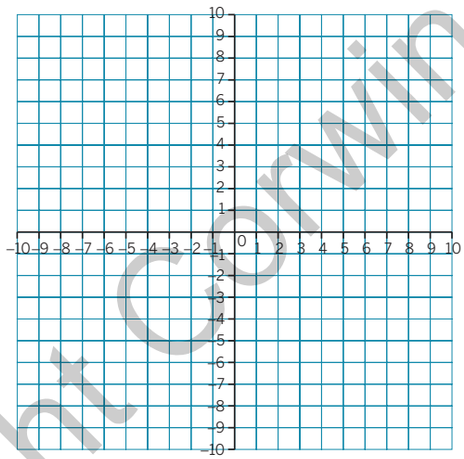
Transformations, Similarity, and Congruence

TASK 38A

Create a quadrilateral in the coordinate plane.

Perform two transformations on the image.

Describe how each transformation mapped the new image.



About the Task

Transformation is a significant concept that connects to both geometric and algebraic contexts. Students need to build fluency with identifying and applying transformations in and out of the coordinate plane. As students work with transformations, they begin to differentiate between transformations that

PAUSE AND REFLECT

- **How does this task compare to tasks I've used?**
- **What might my students do in this task?**

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generate similar figures and transformations that produce congruent figures. For this task, students create a quadrilateral in the coordinate plane and then must apply two transformations and describe how these transformations map to the new image. As students apply their transformations, it is critical to pay attention to how they are labeling the new vertices of the transformed images to ensure that they are accurately applying the transformation.

Anticipating Student Responses

Students will begin by drawing a quadrilateral somewhere in the coordinate plane. Some students may neglect the directions and draw a figure that is not a quadrilateral. Our students are likely to apply different types of transformations to the figure. The most common transformations will be reflections, translations (slides), or rotations. It's likely that some students will apply the same transformation twice. Some students may attempt to produce a dilation from the center or from one of the vertices. Some students will revisit the original image for the second transformation, while others will transform the newly generated transformed image. Students may accurately transform the image but inaccurately label the image to represent a different type of transformation.

NOTES

WHAT THEY DID

Student 1

Student 1 fails to create a quadrilateral in the coordinate plane. Instead, he creates three points in the plane at (0, 0), (1, 1), and (2, 2). Student 1 incorrectly identifies the coordinate as (2, 3). It appears that Student 1 applies a reflection over the *x*-axis to produce the points (0, 0), (1, –1), and (2, –2). Student 1 doesn't provide any explanation or description of the transformation performed.

Student 2

Student 2 doesn't produce a quadrilateral or label the vertices. Student 2 explains that he performed a reflection and a rotation. His representations appear to represent a reflection over the *y*-axis and a rotation about the origin.

USING EVIDENCE

What would we want to ask these students? What might we do next?

Student 1

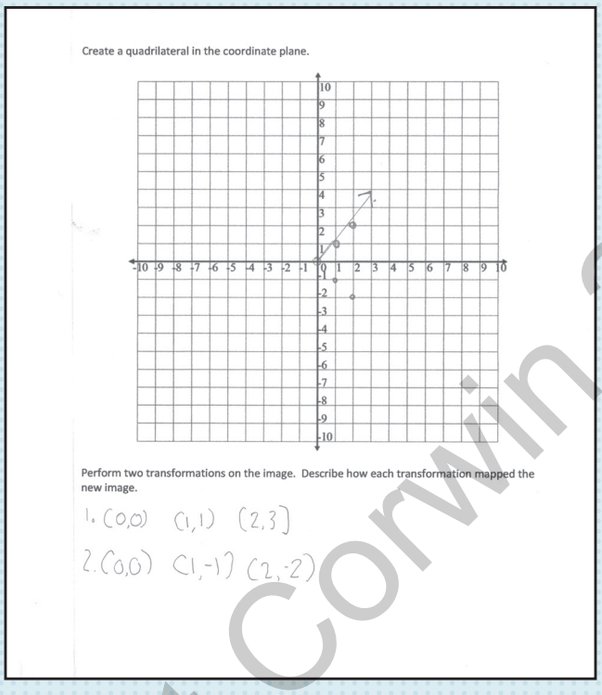
While Student 1 does not provide much work, it appears that he may have some basic understanding of a reflection. We should be sure that he knows what a quadrilateral is and that he can draw and label its vertices. We want to determine what he knows about the possible transformations and that he can model them. We may first have him work with single transformations of a quadrilateral before adding additional transformations. Physical models placed on the coordinate grid or tracing paper may also help him see the impact of these transformations.

Student 2

We can apply similar strategies with Student 2. Again, we want to confirm understanding of quadrilaterals. We should also confirm understanding of labeling. We want to clarify which transformation is represented with each new image. We can provide physical models for him to use at his discretion. After establishing understanding of these transformations and translations, we can challenge him to apply more than one transformation to a shape. As understanding of multiple transformations develops, we can begin to connect these ideas to shapes represented on a coordinate grid.

TASK 38A: Create a quadrilateral in the coordinate plane. Perform two transformations on the image. Describe how each transformation mapped the new image.

Student Work 1

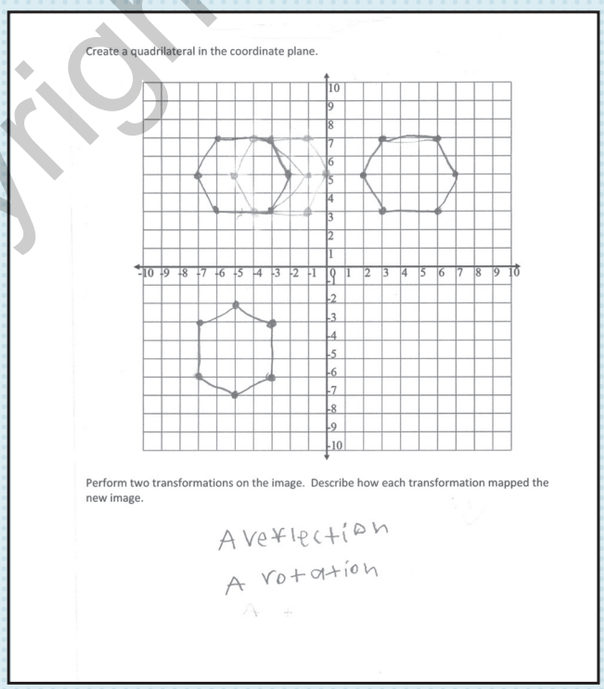

Create a quadrilateral in the coordinate plane.

Perform two transformations on the image. Describe how each transformation mapped the new image.

1. (0,0) (1,1) (2,3)

2. (0,0) (1,-1) (2,-2)

Student Work 2


Create a quadrilateral in the coordinate plane.

Perform two transformations on the image. Describe how each transformation mapped the new image.

A reflection

A rotation

WHAT THEY DID

Student 3

Student 3 draws and labels the vertices of a quadrilateral. He appears to apply a clockwise rotation about the origin. It also appears that he may have performed a translation of the original image. Student 3 has difficulty describing the transformations. He states, "Some went up and down and others went side to side." He doesn't identify which transformations were specifically applied.

Student 4

Like Student 3, Student 4 accurately draws and labels the vertices of a rectangle. The student writes that the one set of images represents a "flip over the *y*-axis." Student 3 also describes that he performed a 90° counterclockwise rotation. It is interesting that he labels the points in his reflected image but not in his rotated image. It may signal less understanding than what we might first assume.

USING EVIDENCE

What would we want to ask these students? What might we do next?

Student 3

Student 3 shows different understanding and misunderstanding than Students 1 and 2. He shows a quadrilateral and applies transformations to it. He can describe what happens in very raw ways. Our work is to help him develop the mathematics vocabulary to accurately and fully describe what is happening in his work. We even begin with less complicated and more ordinary terms to support the development of precise vocabulary. For example, he might use "flip" to develop reflection or "turn" to develop rotation. As his vocabulary grows, we can introduce new, but related, terms and concepts. In this case, we can have him assess if the transformed image is similar or congruent to the original image.

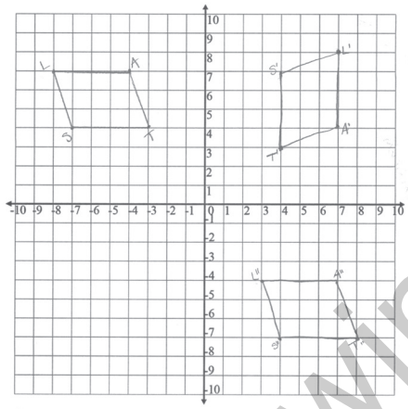
Student 4

Student 4 understands the transformations he performed to some extent. His missing labels of the rotated image may indicate that he can visualize how the image of the shape changes but isn't sure about the result of the specific corners of the quadrilateral. He may need additional work to explore how the relative location of sides or vertices changes as they are transformed. We can support this development by cutting out shapes of clear plastic and labeling their points. After transformations are applied to the clear shapes, Student 4 can observe and record the new locations of these points. As with Student 3, we can have Student 4 consider if the images are similar or congruent. We can also begin to have these students work with applications of multiple transformations to a shape or figure.

TASK 38A: Create a quadrilateral in the coordinate plane. Perform two transformations on the image. Describe how each transformation mapped the new image.

Student Work 3

Create a quadrilateral in the coordinate plane.

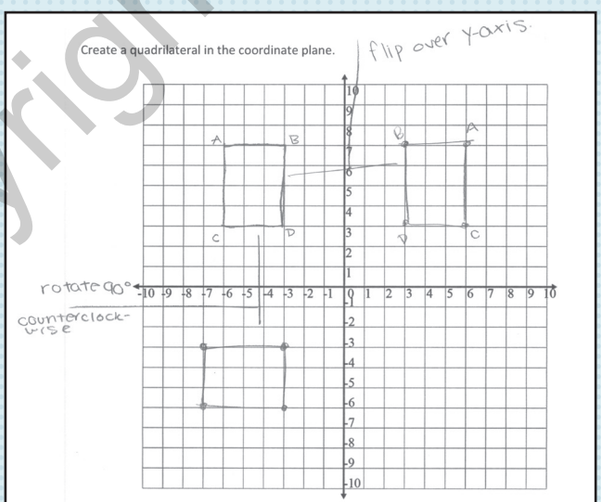


Perform two transformations on the image. Describe how each transformation mapped the new image.

Some went up and down and others went side to side

Student Work 4

Create a quadrilateral in the coordinate plane.



Perform two transformations on the image. Describe how each transformation mapped the new image.

OTHER TASKS

- **What will count as evidence of understanding?**
- **What misconceptions might you find?**
- **What will you do or how will you respond?**

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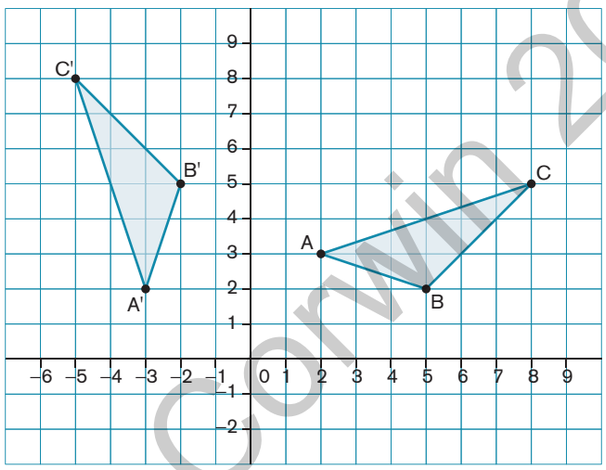
TASK 38B: Describe the transformation or set of transformations that maps triangle ABC onto triangle A′B′C′.

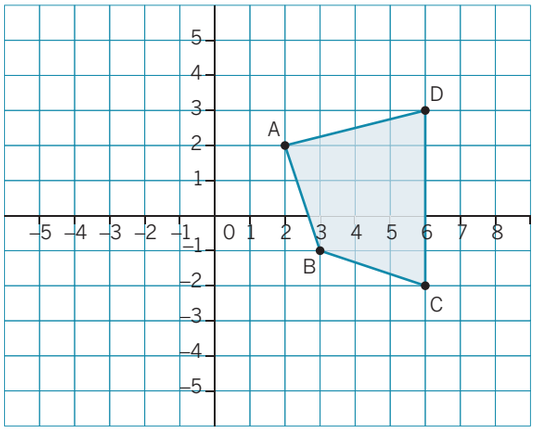


MINING TIP

Students need to differentiate between transformations that produce similar figures and ones that produce congruent figures. Each transformation will produce a similar figure. A congruent figure is a special case of similar figures in which the ratio of the sides is 1:1.

This task requires students to identify the transformation or set of transformations that maps the triangle onto its transformed image. Students may try to use guess and check by selecting a transformation and then testing the points. Most students will recognize that this represents a rotation, but students with refined understanding will articulate that this is a 90° counterclockwise rotation about the origin. For students having trouble recognizing transformations, physical models, clear plastic models (as noted with Student 3 in task 38A), and tracing paper are useful supports. We can have students trace the original triangle (in this case) and vertices and then model how to fold or rotate the tracing paper to test or produce different transformations. *Next, have students identify whether the two images are similar or congruent.* As students use these tools, it is critical that we connect the physical model with the representation with the task or problem.

TASK 38C: Quadrilateral ABCD is shown on the coordinate grid.



Perform two of the following transformations on ABCD and describe how the transformed image compares to the original image.

- **Reflection**
- **180° rotation**
- **90° rotation**
- **Dilation**
- **Translation**

This task is another opportunity to apply understanding of transformations of a quadrilateral. Unlike task 38A, this task provides specific transformations, including a dilation. Students will select the transformations that they are most comfortable modeling. Their choice may also indicate the transformations that we have featured more prominently in our instruction. We should pay attention to the labels of the vertices of the transformed image as well as the clarity with which the student can describe the comparison between images. Students may be able to manipulate the image but be challenged to label the vertices accordingly.

TASK 38D: Sheila performed a transformation on a triangle. She produced an image that has preserved the angle measures of the image.

What transformation might she have performed? Why?

Task 38D examines students' understanding of which transformations preserve angle measure and which preserve distance between vertices. Since the task states that angle measure is preserved, students may select any of the transformations. Some students may select a dilation because only angle measure was specifically referenced. Other students may select one of the transformations that produces congruent figures. When working with these students, we should ask what other attributes are preserved with their specified transformation.