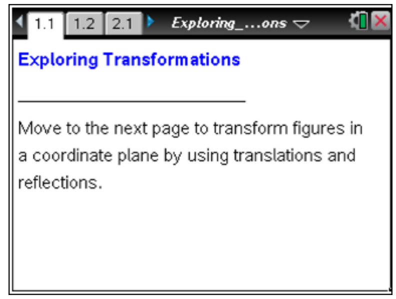
Exploring Transformations

MATH NSPIRED



Math Objectives

- Students will identify the coordinates of a shape that has been translated.
- Students will identify the coordinates of a shape that has been reflected.
- Students will determine the original coordinates of a translated figure given its current coordinates and the directed distance of translation.
- Students will look for and make use of structure (CCSS Mathematical Practice).

Vocabulary

- pre-image
- image
- reflection
- transformation
- translation

About the Lesson

- This lesson involves translating and reflecting shapes in the coordinate plane.
- As a result students will
  - Translate a shape horizontally and vertically by grabbing and moving points along a line.
  - Determine the coordinates of the image given the amount of translation.
  - Reflect a shape over the *x*-axis and the *y*-axis by moving points along a line.
  - Determine the coordinates of the image given the direction of reflection.
  - Determine the difference between a reflection and a translation.

TI-Nspire™ Navigator™

- Use Quick Polls to check student understanding.
- Use Class Capture to examine patterns that emerge.
- Use Live Presenter to engage and focus students.
- Use Teacher Software to review student documents.

Activity Materials

- Compatible TI Technologies: TI-Nspire™ CX Handhelds, TI-Nspire™ Apps for iPad®, TI-Nspire™ Software

Tech Tips:

- This activity includes screen captures taken from the TI-Nspire CX handheld. It is also appropriate for use with the TI-Nspire family of products including TI-Nspire software and TI-Nspire App. Slight variations to these directions may be required if using other technologies besides the handheld.
- Watch for additional Tech Tips throughout the activity for the specific technology you are using.
- Access free tutorials at http://education.ti.com/calculators/pd/US/Online-Learning/Tutorials

Lesson Files:

Student Activity

- Exploring_Transformations_Student.pdf
- Exploring_Transformations_Student.doc

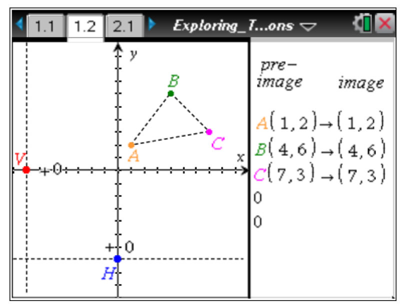
TI-Nspire document

- Exploring_Transformations.tns

Discussion Points and Possible Answers

> **Tech Tip:** If students experience difficulty dragging a point, check to make sure that they have moved the arrow until it becomes a hand ( ) getting ready to grab the point. Press ctrl to grab the point and close the hand ( ).
>
> Note: Press ctrl tab to switch from one application to the other (left side/right side).

Move to page 1.2.



1. Drag point *H* left and right to translate the triangle horizontally. Drag point *V* up and down to translate the triangle vertically.

   a. Identify the coordinates of points *B′* and *C′* if the triangle is translated 4 units to the left. How would you determine the coordinates mathematically?

      <u>Answer:</u> The ordered pair for *B′* is (0, 7), and the ordered pair for *C′* is (3, 3). To determine the coordinates mathematically, subtract 4 from the *x*-coordinate in each ordered pair.

   b. Identify the coordinates of points *B′* and *C′* if the triangle is translated 4 units to the left and 5 units down. How would you determine the coordinates mathematically?

      <u>Answer:</u> The ordered pair for *B′* is (0, 2), and the ordered pair for *C′* is (3, –2). To determine the coordinates mathematically, subtract 4 from the *x*-coordinate in each original ordered pair, and subtract 5 from the *y*-coordinate in each original ordered pair.

2. How must you translate ΔABC for point *B′* to have coordinates (3, 9)?

   <u>Answer:</u> The triangle should be translated 1 unit to the left and 2 units up to produce the new coordinates for *B′*.

3. Herschel moved point *A* to produce a new triangle. He then translated ΔABC left 2 and down 5.

   a. Where would Herschel have placed point *A* for the coordinates of point *A′* to be (–4, –3)?

   Answer: He would have placed point *A* at (–2, 2) for *A′* to have the ordered pair of (–4, –3).

   Teacher Tip: Students can move point *A* to experiment in answering this question. (Point *A′* cannot be moved.)

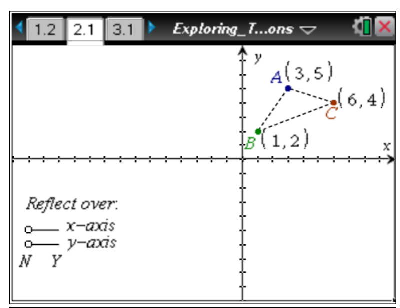
   b. Explain how you can determine the coordinates of point *A* mathematically.

   Answer: Since Herschel translated *A*(*x*, *y*) left 2 and down 5, *A′* is given by the ordered pair (x – 2, y – 5). You can work backwards and find the *x*- and *y*-values by solving the equations $x - 2 = -4$ and $y - 5 = -3$.

   Teacher Tip: Students may mistakenly subtract the values of the shift from the *x*- and *y*-values of the coordinates of *A′*. You should help them understand that they are looking for the position of the original figure (pre-image) and must work backwards.

TI-Nspire Navigator Opportunity: *Open Response Quick Poll*
See Note 1 at the end of this lesson.

Move to page 2.1.



4. Reflect the triangle over the *x*-axis.

   a. Identify the coordinates of points *B′* and *C′* after the triangle is reflected over the *x*-axis.

   Answer: The ordered pair for *B′* is (1, –2), and the ordered pair for *C′* is (6, –4).

   b. How would you determine the coordinates mathematically?

   Answer: To determine the coordinates mathematically, find the opposite of the *y*-coordinate in each original ordered pair.

Teacher Tip: The open circles in the bottom left corner of the screen can be dragged left and right to reflect the triangle over the *x*- and *y*-axes. When the circle is dragged above the Y (for Yes), the triangle is reflected over the indicated axis. When the circle is dragged above the N (for No), the triangle is not reflected.

The original triangle on page 2.1 has vertices *A*(3, 5), *B*(1, 2), and *C*(6, 4).

5. Reset the figure by moving the point back to the *N* position. Reflect the triangle over the *y*-axis.
   a. Identify the coordinates of points *B′* and *C′* after the triangle is reflected over the *y*-axis.

      Answer: The ordered pair for *B′* is (–1, 2) and the ordered pair for *C′* is (–6, 4).

   b. How would you determine the coordinates mathematically?

      Answer: To determine the coordinates mathematically, find the opposite of the *x*-coordinate in each original ordered pair.

6. Describe how a reflection is different from a translation.

   Answer: A reflection flips a shape over while a translation slides a shape to a new location.

TI-Nspire Navigator Opportunity: *True/False Quick Poll*
See Note 2 at the end of this lesson.

Teacher Tip: At this point, you may want to discuss that a translation preserves congruence and orientation of a figure. A reflection preserves congruence but does not preserve orientation.

7. Reset the figure by moving the point back to the *N* position.
   a. Predict the coordinates of points *A′*, *B′,* and *C′* if the triangle is reflected over both the *x*-axis and the *y*-axis.

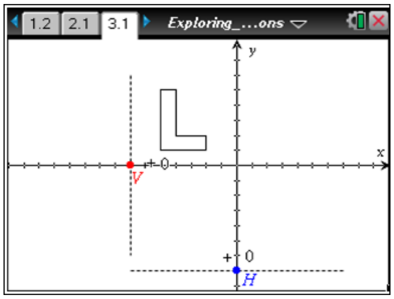
      Answer: The ordered pair for *A′* will be (–3, –5), the ordered pair for *B′* will be (–1, –2), and the ordered pair for *C′* will be (–6, –4).

b. Reflect the figure over both the *x*-axis and the *y*-axis and test your predictions.

c. How would you determine the coordinates of *A′*, *B′,* and *C′* mathematically?

Answer: To determine the coordinates mathematically, find the opposite of the *x*- and *y*-coordinates in each original ordered pair.

Move to page 3.1.



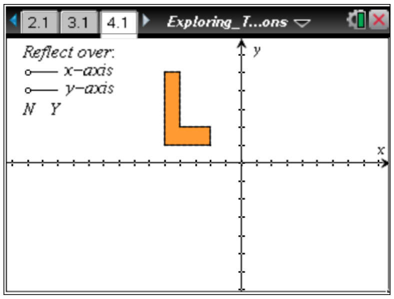
8. Drag the points labeled *V* and *H* so that the **L** lies completely in Quadrant IV. What translations are needed so that the image of **L** lies completely in Quadrant IV?

Sample Answers: Answers may include moving to the right 6 units and down 6 units, or down 6 units and then to the right 6 units.

TI-Nspire Navigator Opportunity: *Class Capture*
See Note 3 at the end of this lesson.

Teacher Tip: Because the *x*- and *y*-axes are not in Quadrant IV, translating the image right 6 and down 6 works, but moving it right 5 and down 5 does not. Discuss with students that H and V are moving by integer values, but the transformations can be numbers other than integers. Make sure students understand that any number greater than 5 will work for either translation.

Move to page 4.1.



9. Move the **L** to Quadrant IV by using the open circles in the upper left corner of the screen.

   a. What transformations were necessary for the image of **L** to appear in Quadrant IV?

Sample Answers: The **L** could be reflected over the *x*-axis and then the *y*-axis or it could be reflected over the *y*-axis first and then the *x*-axis.

b. Does the order in which the **L** is reflected matter? Why or why not?

Answer: The order in which the letter is reflected does not matter. For example, if a shape has an ordered pair of (3, 4) and it is reflected over the *x*-axis and then the *y*-axis, the resulting ordered pair is (–3, –4). If the same shape is reflected over the *y*-axis and then the *x*-axis, the resulting ordered pair is still (–3, –4).

10. a. In the transformations on pages 3.1 and 4.1, why do you think that the letter **L** was used to illustrate the concept of transformations rather than the letter **H?** Justify your answer mathematically or with a sketch.

Answer: The letter H has two lines of symmetry and looks the same when it is reflected either horizontally or vertically. It is easier to see the results of a reflection with the letter L, which does not have a line of symmetry.

b. What other letters would be good choices to illustrate transformations using reflections?

Sample Answers: G, J, P, Q, R

c. What letters are *not* good choices to illustrate transformations using reflections? Explain your answer.

Answer: Any letter that has a line of symmetry would *not* be a good choice. For example: O, X, C, A, M.

TI-Nspire Navigator Opportunity: *Quick Poll*
See Note 4 at the end of this lesson.

Wrap Up

Upon completion of the discussion, the teacher should ensure that students understand:

- How to identify the coordinates of a shape that has been translated.
- How to identify the coordinates of a shape that has been reflected.
- How to determine the original location of a translated figure given its current location and the amount of translation.
- The difference between translations and reflections.

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Note 1

Question 3, *Open Response Quick Poll*: Have students send their response to 3a through an open response Quick Poll. If students have difficulty with the question, send the following Quick Poll after discussing 3b.

Question: After translating the triangle to the right 3 and up 2, the coordinates of *A'* are (–3, 5). What is the pre-image of *A'*?

Answer: (–6, 3)

Note 2

Question 6, *True/False Quick Poll*: Send the following True/False Quick Poll.

Question: A reflection preserves orientation.

Answer: False

Note 3

Question 8, *Class Capture*: Use Class Capture so that students can see multiple solutions to #8.

Note 4

Question 10, *Quick Poll*: Have students send responses to 10b and 10c through Quick Poll. The visual representation of the letters in the students' responses will help students "see" how many lines of symmetry each letter has, if any.

