



Math Objectives

- Students will identify a translation as an isometry, also called a congruence transformation.
- Students will identify which properties (side length, angle measure, perimeter, area, and orientation) of a figure are preserved in a translation and which are not.
- Students will generalize the relationship between the coordinates of a pre-image and its image in a translation in the coordinate plane.
- Students will look for and make use of structure (CCSS Mathematical Practice).

Vocabulary

- pre-image
- image
- congruence transformation
- isometry
- transformation
- congruent figures
- translation

About the Lesson

- In this lesson students will investigate the meaning of a translation, and they will discover which properties are preserved in a translation and which are not. They will identify and generalize the coordinates of a triangle under translations in the coordinate plane.
- As a result students will:
 - Translate a triangle in horizontal and vertical directions to develop their visualization and special sense of a translation.
 - Describe the consequences of the translation in terms of identifying those properties which are preserved and those which are not, and identify and generalize the coordinates of translations in the coordinate plane.
 - Infer that a translation does not alter any of the measurements of a translated object and as such, a translation is an example of an isometry, or congruence transformation.

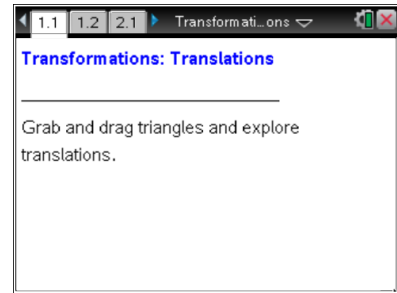


TI-Nspire™ Navigator™

- Use Class Capture to formally assess students' understanding.
- Use Quick Poll to assess students' understanding.

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

- Transformations_Translations_Student.PDF
- Transformations_Translations_Student.DOC

TI-Nspire document

- Transformations_Translations.tns



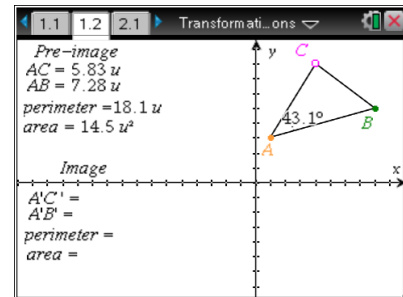
Discussion Points and Possible Answers



Tech Tip: If students experience difficulty dragging a point, check to make sure that they have moved the cursor until it becomes a hand () getting ready to grab the point. Press **ctrl** to grab the point and close the hand (). When finished moving the point, press **esc** to release the point.

Move to page 1.2.

1. a. Grab and drag the open circle to translate the triangle left seven units and down two units.



Tech Tip: Students using the TI-Nspire™ Touchpad might find it easier to use the arrow keys to move the open circle left seven units and down two units.

Teacher Tip: It is possible to move the vertices of the pre-image. If students change the position of the pre-image triangle $\triangle ABC$ prior to performing the transformations stated in part a, their values in the table may be different from the ones shown above. However, the measurements for $\triangle ABC$ should be the same as the measurements for $\triangle A'B'C'$.

- b. Complete the table below for the pre-image $\triangle ABC$ and the translated image $\triangle A'B'C'$.

Answers: Answers are in the table below.

	$\triangle ABC$	$\triangle A'B'C'$
Side length	$AB = 7.28$	$A'B' = 7.28$
Angle measure	$m\angle A = 43.1^\circ$	$m\angle A' = 43.1^\circ$
Side length	$AC = 5.83$	$A'C' = 5.83$
Area	$14.5 u^2$	$14.5 u^2$
Perimeter	$18.1 u$	$18.1 u$



TI-Nspire Navigator Opportunity: *Class Capture*

See Note 1 at the end of this lesson.

2. Two figures are **congruent** if they have the same size and same shape. Is $\triangle ABC$ congruent to $\triangle A'B'C'$? Explain your reasoning.

Answer: Yes, the triangles are congruent because they are the same size and the same shape. There is no change in the side lengths or angle measurements.



TI-Nspire Navigator Opportunity: *Quick Poll*

See Note 2 at the end of this lesson.

3. Change the pre-image of the triangle by dragging one of its vertices and observe the changes in the translated image. Are the pre-image and image of the triangle congruent? Explain your reasoning.

Answer: Yes, they are still the same size and shape.



TI-Nspire Navigator Opportunity: *Class Capture*

See Note 3 at the end of this lesson.

4. An **isometry** is a transformation that produces an image that is congruent to the pre-image. Is the transformation of an object using translation an isometry? Explain your reasoning.

Answer: Yes, because the pre-image and the image are congruent.

Teacher Tip: This is an example of an isometry because it is a congruence transformation. The measurements of all sides and angles are preserved by translating. Since all of the corresponding pairs of parts are congruent, the triangles are congruent.



TI-Nspire Navigator Opportunity: *Quick Poll*

See Note 4 at the end of this lesson.

5. If the clockwise order of the vertices of the image and the pre-image is the same, the figures are said to have the same **orientation**.
- a. Do $\triangle ABC$ and $\triangle A'B'C'$ have the same orientation? Why or why not?

Answer: Yes, they have the same orientation. The order of the vertices does not change.



b. Does your answer to 5a depend on the location of the pre-image triangle?

Answer: No, the pre-image and image triangle have the same orientation no matter where $\triangle ABC$ is positioned.

c. Does your answer to 5a depend on the direction or amount of translation?

Answer: No, I can translate the triangle in any direction and by any amount and the orientation does not change.

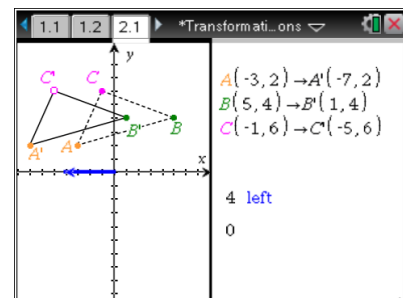
6. Consider the properties of side length, angle measure, perimeter, area, and orientation. Which of these properties are preserved in a translation? Which are not preserved in a translation?

Answer: All of these properties are preserved because the pre-image and the image have the same side length, angle measure, perimeter, area, and orientation.

Teacher Tip: Discuss with students which other transformations preserve which properties; a common misconception is that ALL properties are preserved in ALL transformations, which is not the case. Reflections do not preserve orientation, and dilations do not preserve side length, perimeter, or area.

Move to page 2.1.

7. a. If $\triangle ABC$ has vertices $A(-3, 2)$, $B(5, 4)$, and $C(-1, 6)$, predict the coordinates of the vertices of $\triangle A'B'C'$ for each of the translations in the table below.



Translation	Coordinates of A'	Coordinates of B'	Coordinates of C'
$\triangle ABC$ is translated left 4 units	$(-7, 2)$	$(1, 4)$	$(-5, 6)$
$\triangle ABC$ is translated up 2 units	$(-3, 4)$	$(5, 6)$	$(-1, 8)$
$\triangle ABC$ is translated right 2 units and down 7 units	$(-1, -5)$	$(7, -3)$	$(1, -1)$

Teacher Tip: Remind students to read and follow the directions for question 7. The triangle on page 2.1 must have coordinates of $A(-3, 2)$, $B(5, 4)$, and $C(-1, 6)$. Students may need to grab and drag vertices as needed.



- b. Grab and drag the open circle at C' to perform each of the translations in question 7a. Verify or revise your predictions.

8. The coordinates of a point P are (x, y) .

- a. What are the coordinates of the new point, P' , when P is translated 3 units to the right?

Answer: $P(x, y) \rightarrow P'(x + 3, y)$

- b. What are the coordinates of the new point, P' , when P is translated 5 units to the left?

Answer: $P(x, y) \rightarrow P'(x - 5, y)$

- c. What are the coordinates of the new point, P' , when P is translated up 5 units?

Answer: $P(x, y) \rightarrow P'(x, y + 5)$

- d. What are the coordinates of the new point, P' , when P is translated down 7 units?

Answer: $P(x, y) \rightarrow P'(x, y - 7)$



TI-Nspire Navigator Opportunity: Quick Poll

See Note 5 at the end of this lesson.

9. Generalize your findings. If the coordinates of a point P are (x, y) :

- a. What are the coordinates of the new point, P' , when P is translated h units to the right and v units up?

Answer: $P(x, y) \rightarrow P'(x + h, y + v)$

- b. What are the coordinates of the new point, P' , when P is translated h units to the left and v units up?

Answer: $P(x, y) \rightarrow P'(x - h, y + v)$

- c. What are the coordinates of the new point, P' , when P is translated h units to the right and v units down?

Answer: $P(x, y) \rightarrow P'(x + h, y - v)$

- d. What are the coordinates of the new point, P' , when P is translated h units to the left and v units down?

Answer: $P(x, y) \rightarrow P'(x - h, y - v)$



Wrap Up:

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

- Understand that a translation is an isometry or congruence transformation.
- Recognize that length, perimeter, area, angle measurement, and orientation are preserved in a translation.
- Identify coordinates of an image that is translated horizontally, vertically, or both.
- Generalize the relationship between the coordinates of a pre-image and its image in a translation in the coordinate plane.



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Note 1

Question 1, Class Capture: After students complete question 1a, use Class Capture to be sure students translated the triangle correctly. Then, have students add a Notes page to Problem 1 of the .tns file (1.3) by clicking and record the values placed in the table of question 1b on this page. Use Class Capture to assess students' work.

Note 2

Question 2, Quick Poll: Use Quick Poll to check students' answers to question 2.

Note 3

Question 3, Class Capture: Tell students to stop after they complete question 3. When all students have finished, use class capture to allow the class to see the different triangles students used and the corresponding results.

Note 4

Questions 4, 5, 6, 7, Quick Poll: Use Quick Poll to check students' responses to questions 4–6. Have students answer question 6 for reflections, dilations, and rotations. Check students' responses using Quick Poll. (You might want to assign a different translation to different groups in the classroom.) After students complete question 7, use Quick Poll to ask, "How many of the 9 predictions on the chart did you answer correctly the first time?" Use the results to determine students understanding of translations and discuss any misunderstandings they still may have.

Note 5

Questions 8 and 9, Quick Poll: Use Quick Poll to check students' answers to questions 8 and 9.