Math Objectives

- Students will use tiles to create border patterns (or frieze patterns).
- Students will identify transformations used to create border patterns.
- Students will identify each transformation as an isometry, or congruence transformation.
- Students will identify which properties (side length, angle measure, perimeter, area, and orientation) are preserved with each border pattern created.

Vocabulary

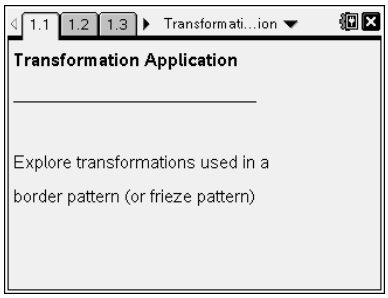
- border pattern
- frieze pattern
- transformation
- translation
- reflection
- isometry
- congruence transformation

About the Lesson

- This lesson involves creating border patterns with tiles using step-by-step instructions to complete transformations such as translation, vertical reflection, and horizontal glide reflection.
- As a result, students will:
  - Identify transformations used to create border patterns.
  - Identify transformations as an isometry, or congruence transformation.
  - Identify which properties are preserved and which are not for each transformation.

TI-Nspire™ Navigator™ System

- Use Screen Capture to examine patterns that emerge.
- Use Teacher Edition computer software to review student documents.



TI-Nspire™ Technology Skills:

- Download a TI-Nspire document
- Open a document
- Move between pages
- Grab and drag a point
- Grab and drag a rectangle

Tech Tips:

- Make sure the font size on your TI-Nspire handhelds is set to Medium.
- You can hide the function entry line by pressing ctrl G.

Lesson Materials:

Student Activity

Transformation_Application_Student.pdf

Transformation_Application_Student.doc

TI-Nspire document

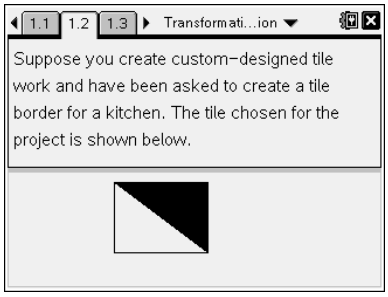
Transformation_Application.tns

Visit www.mathnspired.com for lesson updates and tech tip videos.

Discussion Points and Possible Answers

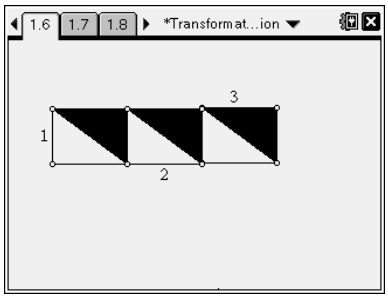
Tech Tip: If students experience difficulty dragging a point or rectangle, check to make sure that they have moved the cursor until it becomes a hand (☜) getting ready to grab the object. Also, be sure that the word *point* or *rectangle* appears, not the word *text*. Then press (ctrl) (☜) to grab the object and close the hand (✊).

Move to page 1.2.



Suppose you create custom-designed tile work and have been asked to create a tile border for a kitchen. The tile chosen for the project is shown on page 1.2, and you need to design the pattern. You decide to create three different border patterns (also called frieze patterns) using the chosen tile. A border pattern extends to the left and right in such a way that the pattern can be mapped onto itself by using a transformation or a combination of transformations.

Move to page 1.6.



Follow the instructions below to create the first border pattern on page 1.6.

1) Grab the bottom segment of the tile and move it so that the left side lines up with the right side of the first tile. Be sure to line up the holes.
2) Repeat the process by grabbing the bottom of the first tile and moving it to line up with the right side of the second tile.
3) When the border pattern is complete, the tile numbers should be in the order 1, 2, 3.

TI-Nspire Navigator Opportunity: *Quick Poll*
See Note 1 below.

Teacher Tip: You may want to demonstrate how to drag and move the rectangles. For each rectangle, students may need to press (tab) until the correct rectangle name is shown.

1. What type of transformation does the first border pattern represent? Explain.

   Answer: Because the tiles were shifted to the right, the type of transformation used to create the first border pattern is translation. This is an example of a hop pattern.

   Teacher Tip: Depending on how familiar students are with border pattern transformations, you may want to provide the 7 classifications: 1) translation, or hop; 2) translation and horizontal glide reflection, or step; 3) translation and vertical reflection, or sidle; 4) translation, vertical reflection, and horizontal reflection, or spinning hop; 5) translation, vertical glide reflection, and 180° rotation, or spinning sidle; 6) translation and horizontal glide reflection, or jump; and 7) translation, horizontal glide reflection, vertical glide reflection, and 180° rotation, or spinning jump. Another option would be to provide the names of the 3 transformations used in this activity and have students decide which are used for the 3 border patterns.

2. Is the first border pattern an example of isometry (also called a congruence transformation)? Explain.

   Answer: The first border pattern is an example of isometry, because the size and shape of the tile remain the same.

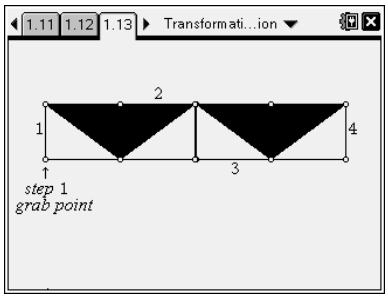
3. If the height of one tile is 3 inches and the width is 4 inches, how long is the first border pattern? How many tiles would be needed to create a border along a 14-foot wall? Show your work below.

   Answer: To find the number of tiles needed to border 14 feet, first convert feet to inches: (14)(12) = 168 inches. Now divide the total inches by the width of a tile: 168/4 = 42. The total number of tiles needed is 42.

TI-Nspire Navigator Opportunity: *Quick Poll*
See Note 2 below.

Teacher Tip: Students were asked to decide if the first border pattern was an example of isometry. The purpose of Question 3 is for students to use the idea that length is preserved through translation.

Move to page 1.13.



Follow the instructions below to create the second border pattern on page 1.13.

1) Grab the lower-left circle of the tile to grab rectangle 2 and drag it to the right until it is lined up next to the first tile.
2) Grab the bottom of the first tile (rectangle 3) and drag it so it lines up with the right side of the second tile, lining up the holes.
3) Grab the bottom of the first tile (rectangle 4) and drag it to an empty space at the bottom of the page.
4) Grab the left-bottom point of rectangle 4 and drag it to the right until the tile has flipped.
5) Grab the bottom of rectangle 4 and move it next to rectangle 3, lining up the holes.
6) The tiles should be in the order 1, 2, 3, 4.

Teacher Tip: It is important that students read and follow the step-by-step instructions carefully. Also, it may be helpful to remind students to read what object is being grabbed before moving it. If students need to restart, have them separate all four tiles and restack them with tile 1 on bottom, followed by 4, 3, and then 2 on top. Make sure all tiles are oriented with the white triangle on the bottom-left side of the rectangle. Students can also undo their actions by pressing ctrl Z repeatedly until all of the rectangles are stacked.

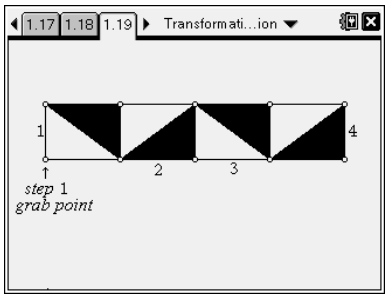
4. The second border pattern uses a combination of two transformations. Can you name them?

   Answer: The two translations used to create the second border pattern are translation and vertical reflection. This is an example of a sidle pattern.

5. Is the second border pattern an example of isometry (also called a congruence transformation)? Explain.

   Answer: The second border pattern is an example of isometry because the size and shape of the tile remain the same.

Move to page 1.19.



Follow the instructions below to create the third border pattern on page 1.19.

1) Grab the bottom-left corner of the tile (rectangle 2) and flip the tile up.
2) Grab the top of rectangle 2 and move the tile so it lines up with the first tile, lining up the holes.
3) Grab the bottom of the first tile (rectangle 3) and move it next to the second tile, lining up the holes.
4) Grab the bottom-left corner of the first tile (rectangle 4) and flip the tile up.
5) Grab the top of rectangle 4 and move the tile so it lines up with the third tile, lining up the holes.
6) The tiles should be in the order 1, 2, 3, 4.

Teacher Tip: It is important that students read and follow the step-by-step instructions carefully. Also, it may be helpful to remind students to read what object is being grabbed before moving it. If students need to restart, have them separate all four tiles and restack them with tile 1 on bottom, followed by 4, 3, and then 2 on top. Make sure all tiles are oriented with the white triangle on the bottom-left side of the rectangle.

6. The third border pattern uses a combination of two transformations. Can you name them?

Answer: The two translations used to create the third border pattern are translation and horizontal glide reflection. This is an example of a step pattern.

7. Is the third border pattern an example of isometry (also called a congruence transformation)? Explain.

Answer: The third border pattern is an example of isometry because the size and shape of the tile remain the same.

8. Determine which of the properties listed in the table below were preserved with the transformations of tiles used in this activity. Write Yes or No in each box.

Properties	First Border Pattern	Second Border Pattern	Third Border Pattern
Side Length	Yes	Yes	Yes
Angle Measure	Yes	Yes	Yes
Perimeter	Yes	Yes	Yes
Area	Yes	Yes	Yes
Orientation	Yes	No	No

Wrap Up

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

- How transformations can be used to create a tile border.
- The definition of a border pattern, or frieze pattern.
- How to identify translation, vertical reflection, and horizontal glide reflection.
- How to identify a transformation as an isometry, or congruence transformation.
- Properties that are preserved with translation, vertical reflection, and horizontal glide reflection.

Assessment

Ask students to create another border pattern using the tile. Then have them answer Questions 1–8 with regards to the new pattern.

TI-Nspire Navigator Opportunities

Note 1

Whole Document, *Live Presenter/Screen Capture*

Pick a student to be a Live Presenter to show the class how to move each rectangle. Use Screen Capture throughout the lesson to ensure students understand the steps they need to take and can correctly manipulate the rectangles.

Note 2

Question 3, *Quick Poll*

This would be a good place for a Quick Poll to ensure student understanding. Ask students to answer this question: If the height of one tile is 3 inches and the width is 5 inches, how long is the first border pattern?