Math Objectives

- Students will trace over different objects, digitize them, and then manipulate the ordered pairs that represent the shape to transform it in various ways.
- Students will reason abstractly and quantitatively, and they will look for and make use of structure (CCSS).
- Students will understand congruence and similarity using physical models, transparencies, or geometry software.
- Students will describe the effect of dilations, translations, rotations, and reflections (CCSS Mathematical Standard).

Vocabulary

- dilation
- translation
- rotations
- reflections
- transformation
- digitizing
- coordinate

About the Lesson

- This lesson involves digitizing an image and transforming it on a graph.
- As a result, students will:
    - Use the drawing tool to trace over an image on a Geometry page.
    - Manipulate the shape's coordinates in a spreadsheet to Dilate, Translate, Rotate, and Reflect it.
    - Decide how to alter the lists of points and then look at the transformed shape with the original in a graph.
    - Experiment and demonstrate alternative solutions to each transformation.

TI-Nspire™ Navigator™ System

- Send and Collect Files.
- Use Screen Capture to examine student work and responses.
- Use Quick Poll to collect different methods for each transformation.
- Use Live Presenter to allow students to show their work.

TI-Nspire™ Technology Skills:
- Download a TI-Nspire document
- Open a document
- Move between pages
- Grab and drag a point

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 Files:
Student Activity
Transformers_in_the_Classroom_Student.pdf
Transformers_in_the_Classroom_Student.doc
TI-Nspire document
Transformers_in_the_Classroom.tns

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

Activity Materials

- Graph paper to explore possible effects of individual transformations—optional.
- Camera or scanner to collect images to digitize and transform on the TI-Nspire.

Discussion Points and Possible Answers

Tech Tip: The TI-Nspire document has three programs in it that have to be executed if you add more problems. They are installed and running in the current .tns file.

> draw() ‣ Done
> gap() ‣ Done
> reset() ‣ Done

The Geometry Page where the students trace has a Reset and an On/Off button.
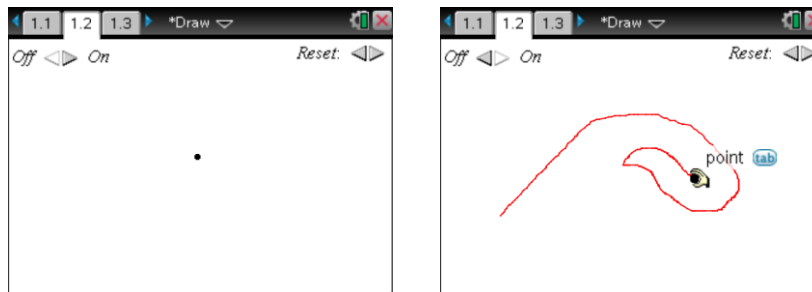
Students will have a bit of trouble making this work, so they should try out the tracing many times. Once they get the sequence right, they might make some errors on the trace. They can just Reset, reposition the drawing point, and then turn the trace back On.

The document has the General Settings set to "Fix 2," but you might want to explore and change this value and maybe the Window settings as well. This might result in ordered pairs that are more in tune with your students' psyches.

> When you introduce an image, you might need to resize it. To do this on the Geometry Page, you need to get off of the grid, right-click (ctrl menu) and then select the image. Then grab one of the handles in a corner and resize. See the lower right-hand corner in the image below. Make sure you don't deform the image by grabbing the sides, unless you wish to do so.
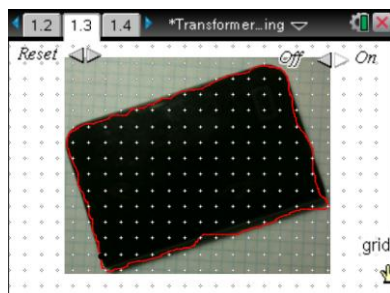
Move to page 1.3.

1. On this page, you will use the buttons at the top of the page to Reset the drawing tool and to turn it on.
    *   On your first try, you can just grab the point (with ctrl 🖑), and then move it to the start of your tracing.
    *   Once you have the point at one of the corners of the object, turn the tool on, and grab the point as before.

    *   Now carefully and slowly trace all around the object, ending at the point that you started.
    *   If you mess up the trace, then just press the Reset, reposition the point, turn the tool back on, and grab the point and trace again.
    *   Using the tab will help you move from the buttons to the point to trace.
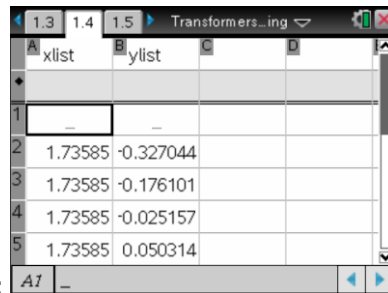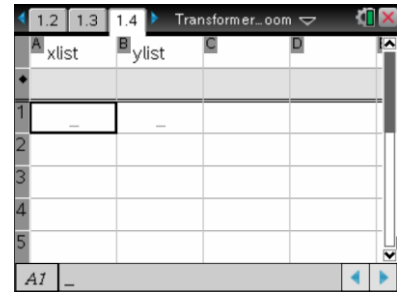   *   After you are finished tracing, move on to the next page.
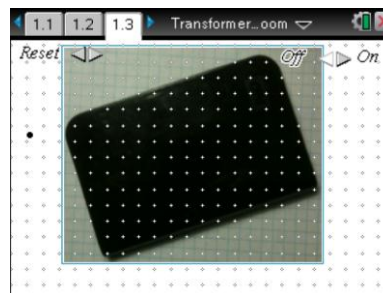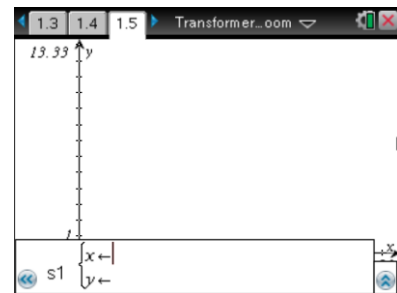
Sample Answers:

Move to page 1.4.

2. On this page, you will see the coordinates that represent the
    outline of the shape. That is, you have digitized it. Examine
   the points in your spreadsheet.

Sample Answers:

Move to page 1.5.

3. On this page, you will set up a plot of the shape you digitized.
    *   Use the Scatter Plot, and select the xlist for x and the ylist
        for y.
    *   If this plot does not look close enough to the original, return
        to the image page, and Reset so you can trace again.

Tech Tip: Use ⌈ctrl⌉ ⌈G⌉ to open the Entry Line if it has closed on you. Right-click (⌈ctrl⌉⌈menu⌉) to change
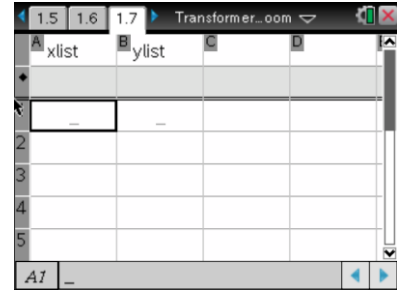the Graph Type to Scatter Plot, if this goes away.

Sample Answers:
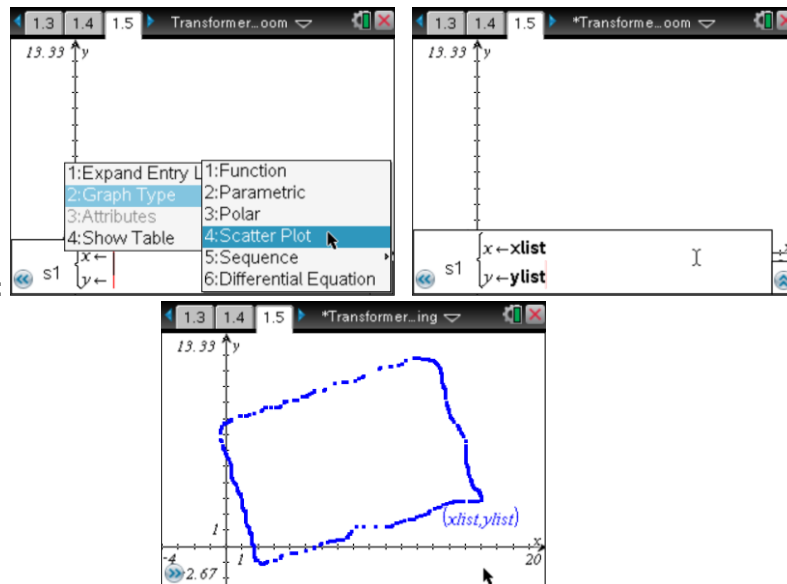
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│ **TI-Nspire Navigator Opportunity:** *Screen Capture*   │
│ **See Note 1 at the end of this lesson.**   │
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Move to pages 1.6 through 1.8.

Now, Transform your figure! We have several options: Dilations, Rotations, Reflections, and Translations.

4. On Page 1.7, create a set of data from your xlist and ylist for the original figure so the figure is *dilated*.

   - To dilate a shape, you will need to change the x and y values by multiplying by a number larger than 1 (to make the shape larger) or a number between 0 and 1 to shrink it.
   - In Columns C and D at the top of the column, name these lists with names like **bigx** and **bigy** or **smallx** and **smally**, depending on how you want to dilate.
   - Then move to the formula cell marked by a diamond, and type, for example, **=xlist*0.5** into the **smallx** column and **=ylist*0.5** in the **smally** column (assuming you what to dilate the shape by 50%).

5. Decide what you type of dilation you want and by what factor you want to dilate.

Tech Tip: Make sure you are on the correct row and cell to name the list and to calculate on it. Names go on the very top cell and calculations are placed in the next row (the diamond row).
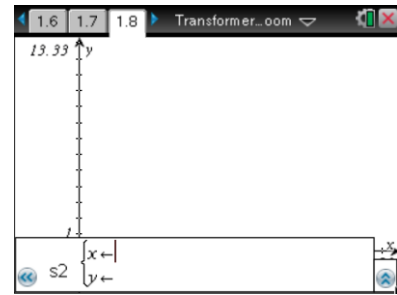
Sample Answers:

On page 1.8, we want to look at the plot of both figures, the original and the dilated one. You might need to adjust your Window to see both figures.

6. You will need to set up a new plot on s2 to show your new figure and the original. Make sure you use your new list names as created earlier (**smallx**, **smally**).

Tech Tip: Select **MENU > Window > Zoom – Data** or **> Zoom – Out**, if you need to adjust even more.

Sample Answers:

TI-Nspire Navigator Opportunity: *Screen Capture*
See Note 2 at the end of this lesson.

Move to page 1.9 through 1.11.

7. To *reflect* your figure, you will need to change the **xlist**, **ylist**, or both depending on which axis you want to reflect over. Assemble your plan and how you will carry it out.

8. As you create your new lists in the spreadsheet on Page 1.10, make sure you use unique names and then use the xlist and ylist in your calculation on the diamond line.
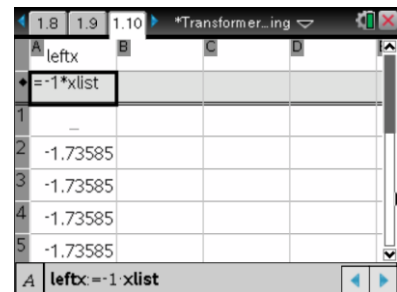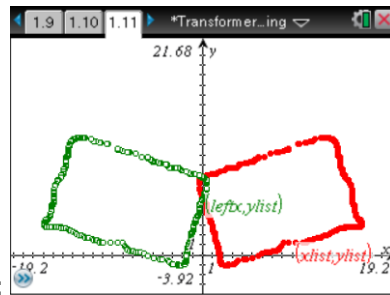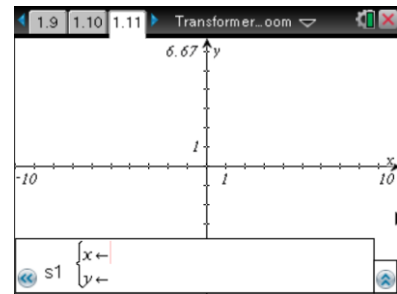
TI-Nspire Navigator Opportunity: *Screen Capture and Live Presenter*
See Note 3 at the end of this lesson.

Teacher Tip: To reflect over the y-axis using the (x,y) coordinates, you would plot (-x,y). To reflect over the x-axis, we have (x,-y); and to reflect over the origin, we use (-x,-y). Use the signs of the points in the 4 Quadrants to help students see this.

9. On Page 1.11, set up two scatter plots: the original shape
    (**xlist**,**ylist**) and the new plot to show the reflection. Recall that
    you will need to use `ctrl` `G` to open the Entry Line if it closes
    on you, and you will probably need to adjust the Window again.

Sample Answers:

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

Move to pages 1.12 through 1.14.

10. On page 1.13, name the new list(s), and calculate what is
    needed to *translate* the figure. Make sure you use unique
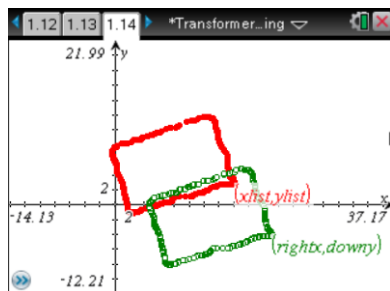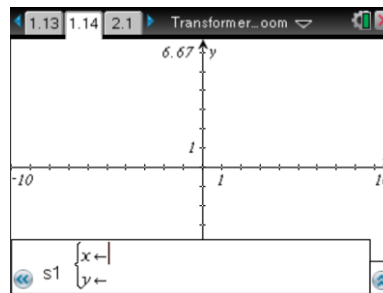   names.

> **Teacher Tip:** To translate, just add or subtract a value to the xlist and/or
> ylist. So (x,y) could become (x+5,y-7).

TI-Nspire Navigator Opportunity: *Screen Capture*
See Note 5 at the end of this lesson.

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11. Set up the two plots as before on Page 1.14, and adjust the Window as needed.

Sample Answers:

TI-Nspire Navigator Opportunity: *Screen Capture*
See Note 6 at the end of this lesson.

Move to pages 1.15 and 1.16.

12. Finally, we will *rotate* the figure. Determine what new lists you will create on Page 1.15, and give them with unique names and create as required for the rotation you want.
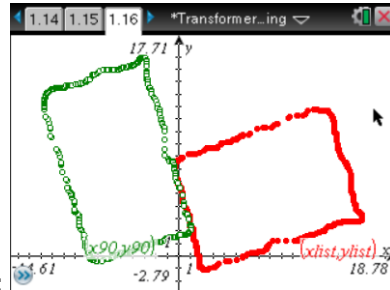
> **Teacher Tip:** To rotate 90 degrees, (x,y) becomes (-y,x); 180 degrees (x,y) becomes (-x,-y); and a 270-degree rotation has (x,y) becoming (y,-x).
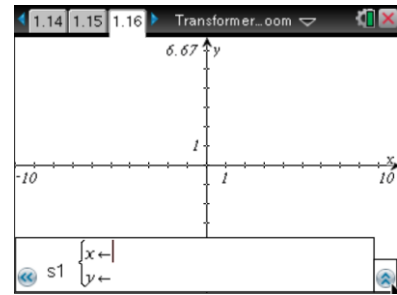

TI-Nspire Navigator Opportunity: *Screen Capture*
See Note 7 at the end of this lesson.

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13. Set up the two plots as before and adjust the Window as needed.

Sample Answers:

TI-Nspire Navigator Opportunity: *Screen Capture*

See Note 8 at the end of this lesson.

Move to Problems 2 and 3, repeating the process above.

> **Teacher Tip:** When the students take their own photos, discuss what shapes might be best to transform, A photo of a letter, or an animal might work well. Placing the image and resizing it with the Teacher Software could be done by the students.

Wrap Up

Upon completion of the lesson, the teacher should ensure that students are able to understand:

- The nature and needs of the four different transformations.
- Some transformations or combinations of formations are equivalent.
- How to undo a transformation.

Extensions and Alternatives

- Explore the UCSMP use of matrices to do transformations, and determine how the TI-Nspire might be able to facilitate the experience.
- Explore the use of the Draw function with other mathematical content.

TI-Nspire Navigator

Note 1: Screen Capture

Take a Screen Capture of all the class to see how well each student was able to digitize the shape.

Note 2: Screen Capture

Take a Screen Capture of all the class to see how they dilated the figure. Discuss how the planned dilation played out and what happened to the coordinates. You might want to move back to the spreadsheet page and get a Screen Capture of the four lists.

Note 3: Screen Capture and Live Presenter

Collect a Screen Capture of the spreadsheets and have the class decide/predict what kind of reflection each person is trying for. Make a particular student the Live Presenter and have them move on to show the plots.

Note 4: Screen Capture and Quick Poll

Collect a snapshot of the class with Screen Capture and classify the types of reflections. Send a Quick Poll using one of the Screen Captures and have the class name the reflection type.

Note 5: Screen Capture

Collect Screen Captures of the spreadsheet, and have students predict where the translated image will land.

Note 6: Screen Capture

Collect a snapshot of the class, and classify the types of translations.

Note 7: Screen Capture

Collect a Screen Capture of the class, and have the students classify the type of rotation.

Note 8: Screen Capture

Take a Screen Capture of the class and discuss the results.