Translations, Rotations, Reflections, Oh My!

Geometer’s Sketchpad

Topic: Translation, rotation and reflection of polygons.

Goals: The students will use Geometer’s Sketchpad to discover the properties of translation, dilation and reflection. They will then apply these properties to create figures of their own design.

Materials: Computer with Geometer’s Sketchpad Software and a pencil/pen.

Grouping: Groups of 1-2 students per computer.

Background: You will need a basic understanding of polygons and integers. You will also need basic computer skills such as mouse/keyboard interfacing and menu navigation.

Directions: Geometer’s Sketchpad (GSP) is an application that allows easy creation and manipulation of geometric constructs. GSP is an extremely versatile application. The following activities cover a small portion of the possible uses for GSP. For further information about GSP and its potential uses visit http://www.keypress.com/sketchpad/.

Activity 1: Introduction to GSP and how to create a polygon

GSP Tools and their uses: There is a toolbar on the left side of the GSP window.
The tools names from top to bottom are.

**Selection Tool** – allows selection of items on screen and is the default tool.

**Point Tool** – places points in the sketch at the place defined by the mouse position.

**Circle Tool** – draws circles in the sketch.

**Straightedge Tool** – allows the user to draw lines, segments, rays, etc.

**Text Tool** – allows the user to make labels and add text to the screen.

**Custom Tool** – allows the user to create customized tools.

*Time to Start:* Experiment with the tools by drawing some points, lines, rays, segments in the sketch. To change the segment tool into a line tool you must place the cursor the tool and right click on the mouse, holding the button on the mouse down you drag the cursor to the right and there will be segments, lines and rays. Once you have the cursor on your choice let go of the mouse button.

*Selection or Highlighting:* Click the Selection tool and then click on one of the points you created on the screen. Notice that the point is now colored pink. This signifies that the object is selected. If you click in the white space on the screen, notice the point is no longer pink. Experiment with the selection tool to answer the following questions.

a) How to select one or more objects?

b) How to deselect objects?

c) How do you know when an object is selected?

**Creating a polygon with points and menus**

Close your sketch, but do not save your experimental work. Open a blank sketch by choosing the **File** menu and selecting “**New Sketch**”. Now we need to set up our coordinate system. Choose the **Graph** menu and select “**Show Grid**”. Next choose “**Snap Points**” also in the **Graph** menu. See the figures below for clarification. See the samples below to view the menus as they should appear.
In this new sketch we will create a polygon.

- Select the point tool
- Holding the shift key, place three (3) points in either clockwise or counter clockwise order.
- With all three (3) points selected in order, go to the Construct menu and select “segments”

You have now created a triangle. Select the Text Tool and click on each of the triangle’s vertices (points). We now have names for the vertices (points). You can double click on the label and type in the box to rename your points if they do not match the facilitator’s labels.
Choose the **Selection Tool**. Click on one of the points to see how the triangle changes as each point is moved. Record your observations below.

Point A:

Point B:

Point C:

Now use the points/segments method to create a square, a rectangle and a pentagon in your sketch.

**Activity 2: Translation, dilation, reflection and rotation of a triangle**

Now that we can create and move a triangle using GSP, we will discover the other ways we can change our triangle. We will use the GSP functions from the Transform menu.

**Translation**

Translating an object means to uniformly change its position in space. Translation is determined by moving an object a given distance in a given direction. This means the size and shape do not change. In this portion of the activity we will learn one method that is used to perform translations using GSP.

1. Create a new sketch and create a new triangle as we did in Activity. Make sure to label the points.
2. Select the triangle by choosing the selection tool and making a box around the whole triangle.
3. Go to the Transform menu and select “Translate…”

![The Geometer's Sketchpad - [Untitled 1]](image)
4. A dialog box will appear on the screen. Set the Translation Vector to “Rectangular”. Next, change the Horizontal distance to 10.0 cm and the Vertical distance to 0. See the figure below for clarification.

(a) What happened to the triangle?

(b) What happened to each point of the triangle with regards to each point’s coordinates?

Select your original triangle and perform another translation. This time, make the Horizontal distance 0.0 cm and the Vertical Distance -4.0 cm.

(c) What happened to the triangle after this translation?

(d) What happened to the coordinates of the vertices of the triangle?

Repeat the translation process a few times with different values to determine the values that make the triangle move up, down, right and left. Record your observations below.

Up-

Down-

Left –

Right –
Reflection
When a point or object is reflected, it must have a reference point and a line to reflect the object over. A reflection is similar to looking in a mirror or into still water. The mirror reflection is similar in nature to the image you obtain after performing a reflection. The following activity covers how to reflect objects using GSP.

1. Using the method from Activity 1, create a new sketch and create a new triangle. Make sure to label the points.
2. Highlight the y-axis (vertical) by clicking it.
3. Go to the Transform menu and select “Mark Mirror”
4. Select the triangle by choosing the selection tool and making a box around the whole triangle.
5. Go to the Transform menu and select “Reflect”.
6. Use the Text Tool to label the points of the new triangle.

(a) What happened to the triangle? Did it change size or shape?

(b) How did the coordinates of each point change?

(c) What did GSP label the vertices of the image?

Explore reflections further by repeating the steps above. Instead of selecting the y-axis for the mirror, try the using the following as a line of reflection one at a time of course:
- x-axis
- a point
- an edge of the original triangle
- any line that you randomly place in your sketch using the line tool

Record what happens below?

X-axis reflection:

Reflection using a point for the mirror:

Reflection using an edge for the mirror:
Reflection using any line:

**Rotation**
Another method of moving an object is rotation. In rotation, a point or object is moved about a fixed point, clockwise or counter clockwise a fixed number of degrees. The center of the rotation is determined by the user in GSP. This activity will demonstrate one method to execute rotation of our triangle using GSP.

1. Create a new sketch and create a new triangle (use the method from Activity 1.) Be sure to label the points.
2. Highlight (select) the origin of the graph (x = 0 , y = 0)
3. Go to the **Transform** menu and select “Mark Center”.
4. We have now selected the point about which we will rotate our triangle.
5. To rotate the triangle, highlight the triangle and then go to the **Transform** menu and select “Rotate…”.
6. The dialog box shown below will appear on the screen. The default angle is 90°. We will use the default value for our first rotation. Select “Rotate” to complete the rotation.
What happened to the triangle? What quadrant is the rotated triangle in? What quadrant is the original triangle in?

What happens if you rotate the image of your first rotation (that is rotate the second triangle) by 90°? What happens to the third triangle if you rotate it by another 90°? What quadrant is each triangle located?

Now pick a one of the vertices of the triangle to mark as your center. Rotate the triangle 90° degrees.

Describe how the image in a 90° differs with the new center you chose.

Experiment with the rotation function by using different rotation angles and different points as the center of rotation. Rotation and translation are called transformations since they transform an object.

Activity 3: Extensions
In this activity we will apply transformations and the tools of GSP to create designs that have specific properties. In a new sketch, try to recreate the following objects.

1. A strip created by using repeated translations.

![Diagram of a strip created by repeated translations]
2. A figure with rotational symmetry.

3. A figure that uses repeated rotations and translations to create a strip.

4. For a totally exciting time, right click on a point in any of your creations go to the **Display** menu and select **"animate point"**. See below for clarification.
Observe what happens to the object. There is a dialog box that appears in the lower right hand portion of the window. Experiment with the animation speed and see what happens. Refer to the dialog box below.

5. Now you can get really creative and come up with your own design by using translation, rotation and/or reflection. Have fun.

If you wish to take home any of your creations, put your name in a text box and print them. **BUT BEWARE** you must first go to the **File** menu and **Print Preview** and press **scale to fit the page** so your sketch will print on only one sheet of paper. We only have a black and white printer available.