***How to Dilate* Teacher Guidelines**

**Role of technology**

The formula for determining the coordinates of the image of a dilation is complicated and hardly intuitive. With the Geogebra, however, and particularly the second coordinate plane that can show up, as well as the intermediary (“auxiliary”) triangles, the formula can be arrived at *much* more easily, albeit still with considerable effort. Each step of the dilation is broken down and can be visualized with the auxiliary triangles, in particular. The second coordinate plane makes clearer the desire, or need, to shift (translate) *everything*, not just the center of dilation. And, again, the sliders help students understand the more continuous nature; it also allows for all coordinates to be identified for students (without them having to count out x- and y-values).

**Teacher Guidelines/Directions for Technology**

This exploration should take a full class period for students to wrap their heads around, so guidelines are quite simple. The technology procedures are the same as in Activity 1.

Start class with a warm-up (technology or not) asking students to recall 3 mathematical things from the previous day – definitions, conjectures, facts, actions the students took, calculations they made, whatever. Collect them and redistribute them randomly. Have students read them out until one reads “dilation.” Have a brief discussion with the class about what happened the previous day and jog their memories as to what dilations are, how they could make things bigger, smaller, or the same size, etc. As a transition into the day’s activity, ask students whether or not they remember about how the image of the Center “moved”; where did it go, where did it “come from”? If asked excitedly and mysteriously enough, this should serve as enough of an engaging hook into the lesson.

During the lesson, monitoring is critical. Nothing will make this lesson fail more than not being aware of what students do not understand. The key to this lesson is not the formula at the end; that formula has its place, and may or may not be tested on. What is important is that students are EXPERIMENTING WITH DILATIONS. This task is all about concepts, not formulas. The notion that one can just “pick up” the coordinate plane is baffling, and students should be made to wrestle with it – not without prompting, though. The primary two questions to prompt students should be:

1. (should be on the topic of dilating) When *do* you know how to find the coordinate of the image (“how to dilate”)?

2. What if we just moved it (the coordinate plane)?

Question 2 seems vague, but seems in my mind to click quite well with the topic. Moving the coordinate plane is as simple as it literally means. Just move it. Perhaps this question can be supplemented with ideas of perspective (how different people view things), maybe even with more scientifically inclined students the notion of frames of reference (how things look while in a moving car, etc.). The two above questions can go a long way. The rest of the content should be clear to the students, but basic questioning should lead students to the important realizations: the relationship between coordinates of pre-image and image when dilation is centered at origin, how translations are represented on the plane, and what exactly the green triangles mean.

After the exploration is finished – which should take an entire 50 minute class – finish with a bit of student discussion and, if possible, a student (or students) presenting what the formula for dilating not from the origin actually is; if no students produce the formula in full, introduce the formula to the students for them to take down in notes. To end class, have students practice two dilations on their own paper or provided graph paper. Such a problem might be:

“If $∆ABC$, with A(2,2), B(-1,3), C(4,-2) is dilated by a scale factor of 3 from center (-2, 2), what are the coordinates of the vertices of the image $∆A'B'C'$? Draw a picture and justify your answer by drawing lines through corresponding vertices.”