Mathematics in this Lesson
Lesson 8

Lesson Description

Sasha and Keoni use a GeoGebra applet to move parabolas to the left, right, up, and down. Then they develop equations for several different parabolas where the vertex is not at the origin.

Targeted Understandings

This lesson can help students:

- Decompose the translation of a parabola on a coordinate grid into two directions: horizontal (left/right) and vertical (up/down).

- Understand that when a parabola is translated left or right, its directrix remains the same, as does the *y*-value of its focus. The *x*-value of the focus is adjusted by the direction and distance of the horizontal movement. The length of the horizontal side of the right triangle used to derive the equation will also reflect the horizontal translation (but the length of the vertical side and the hypotenuse remain the same as for the base parabola).

- Understand that when a parabola is translated up or down, its directrix also moves by the amount of the translation, as does the *y*-value of its focus. The *x*-value of the focus remains the same. The lengths of the vertical side and the hypotenuse of the right triangle used to derive the equation will also reflect the vertical translation (but the length of the horizontal side remains the same as for the base parabola).

Common Core Math Standards

CCSS.M.HSF.BF.B.3: Identify the effect on the graph of replacing *f*(*x*) by *f*(*x*) + *k*, *k f*(*x*), *f*(*kx*), and *f*(*x* + *k*) for specific values of *k* (both positive and negative); find the value of *k* given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology.

In this lesson, Sasha and Keoni connect graphical translations of a base parabola (up, down, left, right, and a combination of these movements) with changes in the algebraic expression of the function. For example, shifting a base parabola with $p = 3$ and vertex at the origin to the right 7 units means that the term $x - 7$ will be in the numerator for the translated parabola ($y = \frac{(x-7)^2}{12}$). When the same base parabola is translated up 2 units, the effect is the addition of 2

units to the equation (which is $y = \frac{x^2}{12}$ for the base parabola and $y = \frac{x^2}{12} + 2$ for the translated parabola).

Common Core Math Practices

CCSS.Math.Practice.MP5: Use appropriate tools strategically

According to the Common Core's description of Math Practice 2, mathematically proficient students "know that technology can enable them to visualize the results of varying assumptions, explore consequences, and compare predictions with data." In this lesson, Sasha and Keoni use the visual tool of a function-translation applet in GeoGebra to decompose the translation of a parabola into horizontal and vertical movements [**Episode 1**, **1:18 – 1:29** and **2:46 – 2:59**]. This imagery is powerful for helping Keoni and Sasha conceive of the effect of translation on the lengths of the right triangle that they use to derive the equation of a parabola [see for example, **4:05 – 4:34** in **Episode 2**].