**Lesson Purpose:** In this 75-minute lesson, students will work in groups to examine, describe, and explain different ways that functions can grow or change, specifically linear, quadratic, and exponential growth. That is, we want them to advance their understanding by being more precise in their thinking about some of the different ways that functions can grow.

They will use SMP 1: Make sense of problems and persevere in solving them, SMP 2: Reason abstractly and quantitatively, SMP 5: Use appropriate tools strategically, SMP 6: Attend to precision, SMP 7: Look for and make use of structure, and SMP 8: Look for and express regularity in repeated reasoning. We will make graphing tools and graph paper available.

CCSS:

F-BF.1: Write a function that describes a relationship between two quantities. (a) determine an explicit expression, a recursive process, or steps for calculation from a context.

F-LE: Construct and compare linear, quadratic, and exponential models and solve problems

**Launch:** Discuss expectations of group work and have someone read the task (Growing Rectangles). Emphasize that we want to know which one is growing faster at any given time. Discuss any questions students might have about what they need to do and emphasize that they will need to show work that supports their conclusions, and that work will need to be clear and complete enough to show and explain at the document camera.

**Anticipating:** Some students will attempt guess and check while other students will probably create tables. They may attempt to write rules but will have difficulty with the quadratic and exponential rules. Most will probably be able to describe the constant change of the area of Family A.

**Monitoring**: Suggest students graph the values in their tables. Ask how the rectangle families are the same and how they are different. Suggest they look for a year when two of the families are the same size and sketch the rectangles, along with the year before and the year after so they can describe how the families are changing. Suggest they write verbal rules for the families in any given year (these will most likely sound recursive).

First whole group discussion:

**Select and sequence**: Select two or three students’ work, one just focusing on the quantity of area and the other on the amount of growth. Work that includes pictures of rectangles around Year 8 would be helpful. Choose a student from each group to explain their work.

**Connect**:

* Help students transition from a focus on areas to the amount of growth of the areas.
* Ask students to provide a verbal description: Describe the growth of each Family.

Family A—steadily growing (amount of growth is constant)

Family B—amount of growth is increasing

Family C—amount of growth is increasing

* Ask questions to emphasize that the area in each family is increasing, but that the amount of growth in each family behaves differently. E.g.
  + How do each of the families change from Year 2 to Year 3? How do each of the families change from Year 8 to Year 9? If we randomly pick any two consecutive years between Year 10 and Year 20, which family would I expect to grow the most in that year? Why?
  + Talk with your neighbor to describe how each family is growing from one year to the next. (Have them share with another pair and revise to get the clearest explanation. Then share with whole class.)
* Be sure to help students differentiate between the amount of growth and the amount of area for each year.

Second discussion

**Select and sequence:** students’ work that will help discuss different ways of dealing with the amounts of growth (sketches of consecutive years of rectangles, graphs, tables, and verbal descriptions).

**Connect**:

* + Family A vs. Families B & C (Include drawings of rectangles.)
    - The amount of growth does not depend on which year it is (Family A) vs. the amount of growth depends on what year it is (Family B & C)
    - The amount of growth is constant vs. increasing
  + Family B vs. Family C (Include drawings of rectangles.)
    - The increment of the amount of growth between consecutive years is constant (In Family B, the amount of growth is steadily growing, i.e. the increment of the amount of growth is 2 square feet)
    - The increment of the amount of growth between consecutive years is determined based on the previous year, and is a multiplicative relationship. So, the ratio of the amounts of growth should be considered to investigate the behavior of the changes in the amount of growth.