Lesson 2: Quadratic Equations and Patterns

Time: Two class periods (50 minutes each)

Grade-Level Expectations Addressed:

A1C10 Compare and contrast various forms of representations of patterns

A1D10 Understand and compare the properties of linear, quadratic, and exponential functions (include domain and range)

G4B10 Draw or use visual models to represent and solve problems

Essential Questions to Guide the Unit and Focus Teaching and Learning:

1. How do patterns help us represent, analyze, make predictions, and draw and justify conclusions from sets of data?
2. How can we use patterns to communicate mathematical ideas?

Specific Classroom Arrangement/Preparations:

Students assigned to groups.

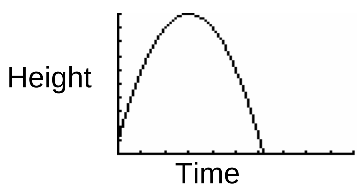
Lesson Materials:

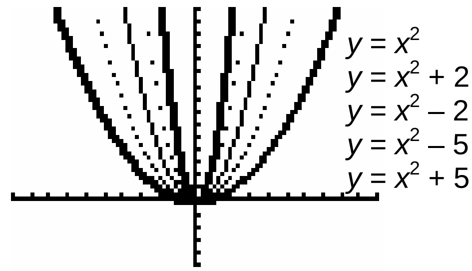
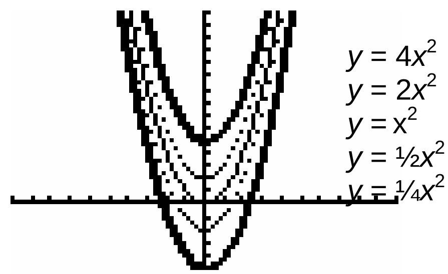
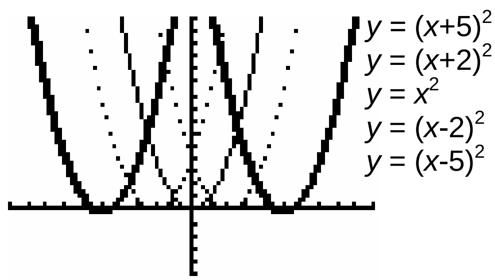
- Graph paper
- Colored pencils
- Worksheet for Lesson # 2
- Scoring guide for Lesson # 2 Worksheet

Technology/Manipulatives/Resources:

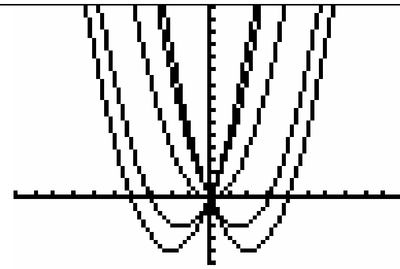
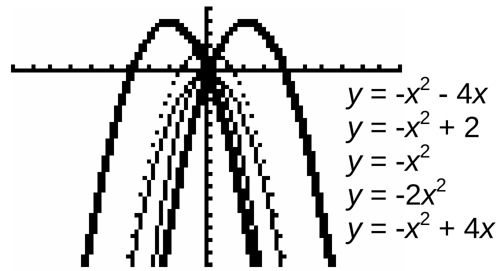
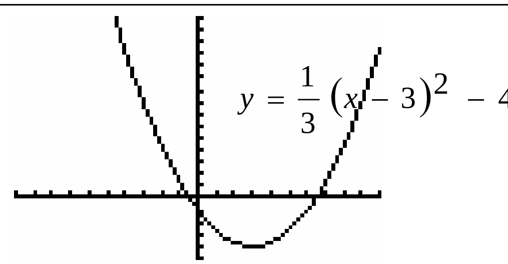
Graphing Calculator (TI-83)

Step-by-Step Process:

Learning Activities	Questions for Students	Teacher Support
Discuss the graph when height is a function of time of a basketball in flight.	**Consider a basketball shot—at time t=0 the basketball leaves the player's hand and gains height as time passes. Eventually the basketball will begin to loose height as time continues to pass. Describe the graph shape when the height of the ball is graphed as a function of the time elapsed** **What differences would exist for the graphs of a basketball shot from the foul line and a basketball shot from the half-court line** **Sketch the graph of such a basketball and label the axes.**  **What other objects have you observed that would have a similar graph?** Rocket, baseball, person coming off a ski jump – any object propelled upward and brought down by gravity. **Have you encountered any mathematical rules that generate a pattern similar to this one? What did these rules have in common?** $y = x^2$; They all have an x^2 term.	Walk around the room and check student sketches.

Graph the following equations on the same coordinate plane. **Parent Function: $y = x^2$** **1: $y = 2x^2$** **2: $y = ½x^2$** **3: $y = ¼\,x^2$** **4: $y = 4x^2$**	**What transformations applied to the parent function yields #1-4?** The 2 makes the graph stretch vertically. The ½ makes the graph shrink vertically. The ¼ makes the graph shrink vertically. The 4 makes the graph stretch vertically. The graphs all touch the origin, but their shapes have changed.	Graphing calculator activity using cooperative groups. (Can be done with grid paper and colored pencils.)  Discuss each activity before continuing.
Graph these equations on a second coordinate plane. **Parent Function: $y = x^2$** **1: $y = x^2 + 2$** **2: $y = x^2 – 2$** **3: $y = x^2 – 5$** **4: $y = x^2 + 5$**	**What transformations applied to the parent function yields #1-4?** The +2 makes the graph move up two units. The -2 makes the graph move down two units. The -5 makes the graph move down three units. The +5 makes the graph move up three units. These are vertical shifts. The shape of the graph does not change.	
Next, graph these equations on a third coordinate plane. **Parent function: $y = x^2$** **1: $y = (x – 2)^2$** **2: $y = (x + 2)^2$** **3: $y = (x + 5)^2$** **4: $y = (x – 5)^2$**	**What transformations applied to the parent function yields #1-4?** The -2 makes the graph move two units right. The +2 makes the graph move two units left. The +5 makes the graph move three units left. The -5 makes the graph move three units right. These are horizontal shifts. The shape of the graph does not change.	
Graph these equations on a fourth coordinate plane. **Parent**	**What transformations applied to the parent function yields #1-4?** The $+4x$ makes the graph move left two units and down four	You might wish to relate this pattern to completing the square. Point out the vertex occurs at $x = -{}^{b}/_{2a}$.

$y = x^2 + 4x$
$y = x^2 + 3x$
$y = x^2$
$y = x^2 – 3x$

Function: $y = x^2$ **1: $y = x^2 + 4x$** **2: $y = x^2 - 3x$** **3: $y = x^2 - 4x$** **4: $y = x^2 + 3x$**	units. The $-3x$ makes the graph move right $^3/_2$ units and down $^9/_4$ units. The $-4x$ makes the graph move right 2 units and down four units. The $+3x$ makes the graph move left $^3/_2$ units and down $^9/_4$ units. The horizontal movement is ½ the coefficient of the x-term and the vertical movement is down the square of the horizontal movement.	
Graph these equations on a final coordinate plane. **Parent Function: $y = -x^2$** **1: $y = -2x^2$** **2: $y = -x^2 + 2$** **3: $y = -x^2 - 4x$** **4: $y = -x^2 + 4x$**	**What transformations applied to the parent function yields #1-4?** The – makes the graph reflect across the x-axis. The -2 makes the graph reflect across the x-axis and stretches the graph vertically. The – and the +2 make the graph reflect across the x-axis then move up two units. The – and the $+4x$ make the graph reflect across the x-axis and move right two units and up four units.	
	What kind of transformations are applied to the parent function to yield $y=\frac{1}{3}(x-3)^2-4$ **? Based on the patterns of change your group discovered, sketch the graph of the equation** $y=\frac{1}{3}(x-3)^2-4$**.**	
	Write an equation of the graph that has a vertical stretch of 2 and is shifted four units to the left and one unit up from the equation $y = x^2$.	The changed equation would be $y=2(x+4)^2+1$ or $y = 2x^2 + 16x + 33$.