Lesson Plan from Curriki, Parabola Party by Dee Wilson

Unit 5: Quadratic Functions and Modeling
The eight lessons (5.1-5.8) provide the instruction and practice that supports the culminating activity in the final unit project. The lessons in this unit focus on working with quadratic relationships.

Lesson 5.2: Real Life Parabolas
In this lesson students discover parabolas in real life and create parabolas on graphs. Students learn about quadratic functions that model a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities and sketch graphs showing key features given a verbal description of the relationship. Students will relate the domain of a function to its graph and when applicable, to the quantitative relationship it describes.

Common Core State Standards by Cluster: (Corresponding Common Core State Standards are listed in parentheses)

<table>
<thead>
<tr>
<th>Grade Level</th>
<th>Cluster</th>
<th>CCS Standard</th>
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<tbody>
<tr>
<td>9</td>
<td>Interpret functions that arise in application in terms of a context</td>
<td>F.IF.4, F.IF.5</td>
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Lesson Preparation and Resources for Teachers:
- TE_Parabola Party, A Curriki Lesson by Dee Wilson
- TE_Parabola Party Lesson Plan by Dee Wilson
- TE_Parabola Focus and Directrix 1 (Video located in Curriki by Sal Khan)
- TE_Parabola Focus and Directrix 2 (Video located in Curriki by Sal Khan)
- TE_Parabola Party PowerPoint (Dee Wilson)
- Real-life Parabola video
- Parabola and Basketball Video
- TE_ParabolaPartyAssessmentSheet
- Flash Video camera or Smart Phone (optional)
- Graph Paper (blank sheet)

Instructional Materials for Students: (print one copy for each student)
- SE_Bell Ringer Worksheet
- SE_ParabolaPartyAssessmentSheet
- SE_ParabolaPartyHomeworkSheet
- SE_ParabolaPartyPairedActivitySheet
- SE_parabolasandtransformations_lp-2
**Time:** 50-minute session

**Lesson Objectives:**
Students will be able to:
- Interpret key features of graphs and table in terms of the quantities
- Sketch graphs showing key features given a verbal description of the relationship (i.e., intercepts; intervals where the function is increasing, decreasing, positive or negative; relative maximums and minimums; symmetries; end behavior, and periodicity)
- Relate the domain of a function to its graph
- Relate the domain of a function to the quantitative relationship it describes
- Identify real-life parabolas
- Create graphs from equations that form parabolas

**Lesson Content:**

1. **Background Building Activity for Students (10 minutes)**

   a. **Vocabulary Building**
   In pairs, students will watch the Parabola Focus and Directrix 1 video by Sal Khan and write a list of the words that should be vocabulary words for this lesson. They will find the math-related definition and write it down. Student pairs should be able to define the words through the context of Sal Khan’s video, but if they need additional assistance, they could go to Mathwords: [http://www.mathwords.com/](http://www.mathwords.com/) or Math is Fun: [http://www.mathsisfun.com/basic-math-definitions.html](http://www.mathsisfun.com/basic-math-definitions.html) for definitions and examples.

   Pairs will work in groups of four to exchange their vocabulary words and create an example for the other group’s vocabulary words. The groups compare examples and discuss the meaning of the vocabulary words.

   Sample words: Parabola, directrix, constant, conic, focus, coordinate, locus, and equidistant.

   b. **Warm Up Problem**
   In real life, we can find many parabolas. Some are man-made and some are natural phenomena. When a dolphin jumps out of the water and back in, he makes an arch that is a parabola. Engineers use parabolas to design rides in amusement parks. A rollercoaster is an example of a series of both up parabolas and down parabolas. There are many other examples in the video.

   Show the video to your whole class and then discuss the different parabolas illustrated.

   [Real-life Parabola video](#)
Let the students discuss their response to the video. Lead the discussion to the conclusion that parabolas can be found in many places. Some examples would be the McDonalds golden arches, the curve of the roof on a Volkswagen Beetle, and the archway in St. Louis. Ask students to work in pairs to go online to find other examples of parabolas and determine their function. Ask the student pairs to create their own invention that is a parabola. They should also explain why they would use that shape for their invention.

2. **Focus Question based on today’s lesson (25 minutes)**
   **Focus Question:** (Write it on the board.)

   How do we graph transformations of the parent function $y = x^2$?

   What is the range of a quadratic function in the upright position as opposed to the range of a quadratic function in the downward position? In other words, when is a parabola going up as opposed going down? Examples: A parabola in the upright position would be the bottom half of a satellite dish. A parabola in the downward position would be McDonalds golden arches.

   **a. Whole Class Activity:**
   **Bell Ringer: Review of Evaluating Expressions and Functions**

   Use the Bell Ringer activity as a review for the students, who should be able to evaluate expressions and functions. Briefly review the answers as a class. (This activity reinforces basic skills.)

   **Directions:** Students work in pairs to complete problems 1-6 on the Parabola Bell Ringer activity.
   1. Evaluate the expression $x - 3$, if $x = 2$.
   2. Evaluate the expression $x^2 - 5$, if $x = 3$.
   3. Evaluate the expression $x^2 - 5$, if $x = -3$.
   4. Given the function, $f(x) = 3x - 7$, find $f(-5)$.
   5. Given the function, $g(x) = -x^2 - 6$, find $g(4)$.
   6. Given the function, $h(x) = -7x^2 + 1$, find $h(-4)$.

   Call on the student pairs to come to the board, write out the problem and walk the class through the solution. This is practice for making a YouTube video that will explain how to solve the problem. Ask students in the class to capture the presentation on video if you have a smart phone or flash camera handy. Student pairs can review and critique their own videos.
Project Geogebra on the board or screen to show students how the graphs should look (located at [www.geogebra.org](http://www.geogebra.org)). Geogebra is a powerful Internet tool that graphs algebraic functions. It serves as a good “checking” device.

b. **Small Group Practice activity**
   Give each student a copy of the Parabola Party Paired Activity Sheet and 10 pieces of candy with the activity sheet. The candy will be used to marked coordinate pairs on the graph. Students work in pairs to complete this activity, which shows the algebraic way to graph an equation. Ask students to identify the maximum, minimum, and intercepts for the parabola. Students can use Geogebra to check their work. Ask student pairs to present their solutions on the board (located at [www.geogebra.org](http://www.geogebra.org)).

3. **Whole Class Discussion (10 minutes)**
   First show the video, *A Basketball Parabola*. Next, use the Parabola Party PowerPoint Presentation to show the transformations learned previously about the quadratic function. Ask students to take notes about the quadratic function.

4. **Assessment**
   Give each student a copy of the Parabola Party Assessment Sheet. The skill practice sheet can be used as an assessment tool to check for understanding about how the transformations affect the graph of a function. (This could be used as informal assessment while monitoring and questioning student.) Collect the completed assessment sheets and review the answers during the next class session.

5. **Extension Activity**
   1. Students work in pairs or small groups to fill out the Parabolas and Transformations worksheet.
   2. The class will work in small groups of four or five to create a YouTube video that explains parabolas and gives examples. They can use props to draw a graph from equations. The Bell Ringer equations can be used or other equations that the students create.
   3. Ask students to work in pairs to search YouTube for more parabola examples.

6. **Homework assignment for additional independent practice** (Note: This homework assignment can be done during a subsequent class period if you have the time.)
Give each student a copy of the Parabola Party Homework sheet. This is their “Ticket Out the Door.” Students should complete the homework sheet and then summarize the main concepts of the lesson.