Lesson Plan

"Launching Pumpkins" - Quadratic Functions with Projectile Motion Simulation

Overview
Learning Goals: ● Students will be able to notice differences between quadratic and linear functions using real-world applications. ● Students will be able to solve quadratic functions for a specific variable.
Standards: ● Solve quadratic equations by inspection (e.g., for $x2 = 49$), taking square roots, completing the square, the quadratic formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as $a \pm bi$ for real numbers a and b. [CCSS.MATH.CONTENT.HSA.REI.B.4.B] ● Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method. [CCSS.MATH.CONTENT.HSA.REI.A.1] ● Understand that the graph of an equation in two variables is the set of all its solutions plotted in the coordinate plane, often forming a curve (which could be a line). [CCSS.MATH.CONTENT.HSA.REI.D.10] ● Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. *For example, rearrange Ohm's law V = IR to highlight resistance R.* [CCSS.MATH.CONTENT.HSA.CED.A.4] **Mathematical Practices:** ● Make sense of problems and persevere in solving them. ● Reason abstractly and quantitatively. ● Construct viable arguments and critique the reasoning of others. ● Model with mathematics ● Use appropriate tools and strategies. ● Attend to precision. ● Look for and make use of structure. ● Look for and express regularity in repeated reasoning.
Curriculum Alignment: ● After introducing solving quadratic functions with various methods: principle of square roots, factoring, completing the square, quadratic formula, and graphing. ● Section 8.4 "Applications Involving Quadratic Equations" from *Intermediate Algebra: Concepts & Applications* by Bittinger
Prior Knowledge: ● Solving linear equations for a quantity of interest. ● Solving quadratic equations using various methods. ● Introduction to linear versus quadratic functions through graphs and equations.

Materials:

- Chromebook (device) for each student
- PhET Projectile Motion Simulation (Sim)
- Desmos Graphing Calculator
- Activity Sheet for each student
- Desmos Link to #7 from Activity Sheet
- Desmos Link to #8 from Activity Sheet
- Exit Slip for each student

Lesson *(50-minute class)*

Warm-Up *(5 - 7 minutes)*:

- Teacher will:
  - Introduce/Provide link to PhET Projectile Motion Simulation (Sim).
  - Remind the students that they will only use the **Intro** 

Button from the Home Screen of the PhET Simulation.
  - Encourage students to take a few minutes to explore/play with the Sim, letting them know that we will only be focusing on the height and angle of the cannon.
- Students will:
  - Take out their Chromebook (device) and log on.
  - Explore the simulation, shooting the cannon at various heights, angles, speed, objects, etc.
  - Respond to teacher's informal questions involving various settings used.

Lesson Activity *(30 - 35 minutes)*:

- Teacher will:
  - Distribute the Activity Sheet to each student.
  - Remind the students that **ONLY** the **height** and **angle** of the cannon will be modified throughout the remainder of the lesson.
  - Allow students to work individually or in partner pairs to complete the activity sheet with their Chromebooks.
  - Circulate the room to be available for questions and ask guiding question:
    - What are the two variables being used in this simulation?
    - What is the relationship between the two variables?
    - Will the trajectory of the pumpkin always be curved, nonlinear?
    - What kind of trajectory would the pumpkin have if gravity did not exist?
    - What part of a function's equation is causing the trajectory to be curved?
    - What part of a function's equation is causing the pumpkin to go up then down, creating a negative parabola that opens downward?
    - What inverse step(s) do you need to do first (second, etc.) to isolate the variable x?
    - When is it more efficient to use Completing the Square to help solve for x?
    - When is it more efficient to use Quadratic Formula to help solve for x?

- Students will:
    - Complete #1 - 8 from the Activity Sheet individually or with a self-selected student partner.
    - Respond to teacher's guided questions.
    - Ask clarifying questions when needed.

Summary/Assessment *(5 - 10 minutes)*:

- Teacher will:
    - Distribute the Exit Slip to each student.
    - Remind students that they will be completing this form individually.
- Students will:
    - Complete Exit Slip and turn in to teacher.