Unit 5 Quadratic Functions and Modeling
The first eight lessons (5.1-5.8) provide the instruction and practice that supports the culminating activity in the final unit project.

Lesson 5.8: Linear, Quadratic and Exponential Functions
In this lesson students learn to construct and compare linear, quadratic, and exponential models and solve problems. They will compare linear and exponential growth to quadratic growth. Students will observe using graphs and tables that a quantity increase exponentially eventually exceeds a quantity increasing as a linear, quadratic, or polynomial function.

Common Core State Standards by Cluster

<table>
<thead>
<tr>
<th>Grade Level</th>
<th>Cluster</th>
<th>CCS Standard</th>
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<tbody>
<tr>
<td>9</td>
<td>Build a function that models a relationship between two quantities</td>
<td>F.BF.2</td>
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<tr>
<td>9</td>
<td>Construct and compare linear, quadratic, and exponential models and solve problems</td>
<td>F.LE.3</td>
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Lesson Preparation and Resources for Teachers:
- TE_5.8 Quadratic Functions PPT (PowerPoint) (contributed by Hazel Keith and Dee Wilson in Curriki)
- TE_5.8 Bellringer (worksheet) (by KC Bellflower in Curriki)
- TE_5.8 Vocabulary Page
- Linear, Quadratic, and Exponential Functions (Sal Khan Video on Curriki)
- Mathematics, Chapter 36, Sequences and Series (free HS textbook)
- Sequences and Series (Sal Kahn Video on Curriki)
- TE_5.8 Repeating Decimals and Geometric Series (Theresa Gallo on Curriki)
- TE_5.8 Car Loan Worksheet answer key
- TE_5.8 Rates of Growth answer key
- TE_5.8 Duckweedlab Worksheet answer key

Instructional Materials for Students (print one copy for each student)
- Graph Paper (optional)
- SE_5.8 Vocabulary Page
- SE_5.8 Bellringer Worksheet
- SE_5.8 CarLoanworksheet
- SE_5.8 RatesofGrowth
Lesson Objective:
Students will:
- Construction linear, quadratic and exponential functions
- Compare linear, quadratic and exponential functions
- Solve problems involving linear, quadratic and exponential functions.

Lesson Content
1. Background building Activity for Students (5 minutes)
   a. Vocabulary Building
      Provide students with the student SE_5.8 Vocabulary Page. Students should create their own definition of the terms, which includes a picture or example. The terms on this list should be familiar to the students. Review these vocabulary terms before continuing the lesson.

   b. Warm-up Problem
      Begin the TE_5.8 Quadratic Function PPT. Allow students a few minutes to solve the Five Problems Mixed Review posted on the first slide. After time has been give to solve, display the second slide and allow students time to assess themselves on their understanding of quadratic functions. Discuss any questions or problems students had with the material.

2. Focus Question based on Today’s lesson (25 minutes)
   Today’s focus question (write it on the board): What methods can be used to compare and solve problems involving linear, quadratic and exponential functions?

   a. Partner or Small Group Activity (teacher observes students while they work to check understanding.) Continue with slides 3 through 39 of the TE_5.8 Quadratic Function PPT. Pause at slide 40 and allow partners or small groups to solve. Provide student with graph paper as needed.

   b. Individual Activity: Show the Sal Kahn Video: Linear, Quadratic, and Exponential Functions. This video compares and has students identify each type of function based on a table of values. After watching the video ask students to create three tables: one that would represent a linear function (as the x-value increases by 1 the y-value will always increase by the same amount); one for a quadratic function (as the x-value increase by 1 the additive change in the y-value is constant); and one for an exponential function (as the x-value increases the y-value is increase by the same multiplying factor). Students should challenge classmates to determine which data table represents each function type.
c. **Small Group Activity:** Explain the difference between an Arithmetic Series (a series where each new term is calculated by *adding* a constant to the previous term) and a Geometric Series (a series where each new term is calculated by *multiplying* the previous term by a constant). Using the tables they created individually, ask students to work in small groups to write the recursive and explicit equations for their linear and quadratic tables.

For example: Given the series: 4, 8, 12, 16, 20...
The recursive equation (an equation written in a form where you need to know the previous term in order to find the next) for this series is $a_n = a_{n-1} + 4$; and the explicit equation (or the closed form, uses the first term and the common difference) for this series is $a_n = a_1 + (n - 1)d$ (where $a_1$ is the first term and $d$ is the common difference).

d. **Whole Class Activity:**
Students share their solutions to the bellringer problems. Discuss as a class methods used to solve the problems. Allow students the chance to share their solutions with the class to help solidify their understanding. Students should ask questions to prepare them for the upcoming assessment.

3. **Assessment Activity (5 minutes)**
Give students the Quiz Graphing Quadratic Functions located on Slide 42—TE_5.8 Graphing Quadratic Functions PPT. Ask students to review their quiz results with a partner. Each partner should take turns explaining his or her solutions to the questions.

4. **Extension Activities**
a. SE_5.8 *Rates of Growth* A collection of problems to encourage students to explore the differences between types of growth, including linear and exponential growth
b. Extending and Refining (slides 44-53) TE_5.8 Graphing Quadratic Functions PPT.
c. SE_5.8 *Duckweed Population Growth Lab*: This lab activity looks at exponential growth in a laboratory setting.
d. Functions: This activity uses beans to show exponential growth.
e. TE_5.8 *Repeating Decimals and Geometric Series* this activity can be used if additional practice on geometric series is needed. (Note: There is no answer key available)

5. **Homework for additional independent practice**
SE_5.8 *Rates of Growth* this is a collection of problems to encourage students to explore the differences between types of growth, including linear and exponential growth.
SE_5.8 Car Loan worksheet, this real world application activity has been modified from Real World Learning Objects, Internet-based Activities for Higher Education. The need to access an online calculator has been removed. Students are asked to price a car, determine an acceptable monthly payment and then using the formula calculate the number of months needed to pay off the loan. This requires solving an exponential equation using logarithms.