Unit 3: Exponential Functions

Content Area: **Mathematics**
Course(s):
Time Period: **Marking Period 2**
Length: **8 Weeks**
Status: **Published**

Summary of Exponential Functions

The concept of a function is extended into exponential relationships. Students will learn how to create mathematical models to represent exponential growth and decay in a variety of contexts, including population change and financial accounts. Students will also learn how to solve basic exponential equations. Sequences reappear in this unit, but now with common ratios instead of common differences. Students will recognize exponential change and understand it from both algebraic and graphical perspectives. This unit will build upon students' prior knowledge of exponents and show many ways in which exponential relationships occur in real life.

Revision Date: July 2024

NJ Standards for Exponential Functions Unit

In accordance with New Jersey's Chapter 32 Diversity and Inclusion Law, this unit includes instructional materials that highlight and promote diversity, including the exponential increase in specific populations across multiple demographics.

MATH.9-12.F.BF	Building Functions
ELA.K-12.1	Developing Responsibility for Learning: Cultivating independence, self-reflection, and responsibility for one's own learning.
MATH.9-12.F.BF.A.1	Write a function that describes a relationship between two quantities.
MATH.9-12.F.BF.A.1.a	Determine an explicit expression, a recursive process, or steps for calculation from a context.
MATH.9-12.F.BF.A.1.c	Compose functions.
MATH.9-12.S.ID.B.6.a	Fit a function to the data (including with the use of technology); use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear and exponential models.
MATH.9-12.S.ID.B.6.b	Informally assess the fit of a function by plotting and analyzing residuals, including with the use of technology.
MATH.9-12.F.BF.B.3	Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$, $k\ f(x)$, $f(kx)$, and $f(x + k)$ for specific values of k(both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology.
MATH.9-12.S.ID.B.6.c	Fit a linear function for a scatter plot that suggests a linear association.
MATH.9-12.F.IF.A	Understand the concept of a function and use function notation
MATH.9-12.F.IF.A.2	Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.
MATH.9-12.F.IF.B.5	Relate the domain of a function to its graph and, where applicable, to the quantitative

	relationship it describes.
MATH.9-12.F.IF.C.7	Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.
MATH.9-12.F.IF.C.7.e	Graph exponential and logarithmic functions, showing intercepts and end behavior.
MATH.9-12.F.IF.C.8	Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function.
MATH.9-12.A.SSE.A.1	Interpret expressions that represent a quantity in terms of its context.
MATH.9-12.A.SSE.A.1.a	Interpret parts of an expression, such as terms, factors, and coefficients.
MATH.9-12.A.SSE.A.1.b	Interpret complicated expressions by viewing one or more of their parts as a single entity.
MATH.9-12.F.LE.A	Construct and compare linear and exponential models and solve problems
MATH.9-12.F.LE.A.1	Distinguish between situations that can be modeled with linear functions and with exponential functions.
MATH.9-12.F.LE.A.1.c	Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.
MATH.9-12.F.LE.A.2	Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (include reading these from a table).
MATH.9-12.F.LE.A.3	Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function.
MATH.9-12.A.SSE.B.3.c	Use the properties of exponents to transform expressions for exponential functions.
MATH.9-12.F.LE.B.5	Interpret the parameters in a linear or exponential function in terms of a context.
CS.K-12.3	Recognizing and Defining Computational Problems
WRK.K-12.P.5	Utilize critical thinking to make sense of problems and persevere in solving them.
WRK.K-12.P.8	Use technology to enhance productivity increase collaboration and communicate effectively.
	Mathematical and computational thinking in 9–12 builds on K–8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.

Essential Questions for Exponential Functions

- What skills are needed to solve basic exponential equations?
- How does one identify and interpret the domain and range for exponential functions?
- What are geometric sequences and how can they be expressed algebraically, using explicit and recursive formulas?
- How can population change over time be modeled by exponential functions?
- How can changes in monetary balances (due to interest rates or depreciation) be modeled by exponential functions?

Enduring Understandings for Exponential Functions

- Knowing basic properties of exponents can be helpful for solving equations with exponents.
- Geometric sequences can be algebraically expressed as exponential functions; geometric sequences may be written using either explicit or recursive formulas.
- Exponential functions serve as appropriate mathematical models for population change, as well as changes in financial balances due to interest rates and depreciation.
- Exponential functions have domain and range, the recognition of which serves to help understand the relationship between values for independent and dependent variables when used to describe situations within a real-life context.

Objectives for Exponential Functions

- How to solve basic exponential equations.
- How to recognize geometric sequences, identify the common ratio, and construct explicit and recursive functions to represent them.
- How to evaluate and graph exponential functions.
- How to identify the domain and range for exponential functions.
- How to construct mathematical models for population change and money growth.
- How to calculate the average rate of change for an exponential function over a stated interval.

Objectives for Exponential Functions

- Working with the properties of exponents and using them to simplify algebraic expressions.
- Creating and evaluating functions for growth and decay models, in relation to money and populations.
- Identifying geometric sequences and expressing them algebraically with exponents.
- Using formulas for geometric sequences to generate a sequence of numbers.
- Choosing an appropriate scale and graphing exponential functions.

Learning Plan for Exponential Functions

1 Week: Use properties of exponents simplify algebraic expressions and review the use of scientific notation for extremely small or extremely large values. Use properties of exponents to arrive at solutions for basic exponential equations.

2 Weeks: Given an exponential function, students practice evaluating and graphing the function on paper and with the aid of a graphing calculator.

2 Weeks: Students work with geometric sequences – identifying the common ratio, using explicit and recursive formulas to write algebraic expressions, and constructing the corresponding graphs. Students use formulas in both directions, first to generate sequences, and then use the common ratio and the first term in the sequence to express the sequence in the structure of the formulas.

2 Weeks: Population and Money – understanding and translating word problems, creating mathematical models to represent real-life scenarios, evaluating exponential functions for changes with population, average rate of change, and money accounts. Class time will be used for the instructor to demonstrate the process, for

students to work individually and collaboratively on practice exercises, and to strengthen their skills using the IXL platform. (If time permits, show a logarithmic graph and discuss its relationship with an exponential graph as its inverse.)

1 Week: Review all topics and assess. Practice test questions, IXL assessment, student portfolio assignment.

Note: At the middle school level, Big Ideas Math will be used in substitute of IXL.

Evidence/Performance Tasks for Exponential Functions

Frequent formative assessments will be utilized at the individual level as opportunities for the instructor to provide critical feedback and ensure that students have grasped fundamental concepts associated with exponential functions. In addition, exploratory classroom activities in small groups will serve as formative assessments in which students can give and receive helpful peer feedback about their understanding of key concepts. Short written quizzes will be administered in the form of exit tickets towards the end of class to identify students' misconceptions and/or struggles with comprehension. Whole group discussion allows for students to verbally articulate their understanding of exponential functions and to elaborate on their conversations from their small group sessions. The unit will conclude with a summative written assessment that addresses real-world applications of exponential functions, as well as the use of proper algebraic notation with geometric sequences. The IXL platform will be used extensively throughout this unit to provide students with countless practice problems, immediate feedback, and an overall SmartScore to track their progress with this topic.

Materials

Core Instructional materials: Lecture notes and classroom activities designed by instructors.

Core Book List including Algebra 1, Pearson Publishing

Supplemental instructional materials: IXL

Suggested Strategies for Modification

Possible accommodations/modification for Algebra 1