

Exponential Function Unit Plan

Grade Level: Algebra 1

Time Frame:

This unit is intended to take 2-3 weeks, depending on the needs of students and the time allocated to mathematics class.

Prerequisite Knowledge:

1. Basic algebra skills:
Algebraic Operations: substituting numbers for letters, simplifying expressions, developing formulas for situations.
2. Create and interpret graphs and data:
Identify patterns in tables and graphs.
Create a graph from a table by hand.
3. Know basics about functions:
Understand how to identify a function.
Know the similarities and differences between linear, quadratic, square root and cubic functions.
4. Basic graphing calculator knowledge
Create a graph from a table of points.
Can find a regression equation for a data set.

Learning Objectives

1. Graph functions expressed symbolically by hand and with technology. (F-IF.7)
2. Identify changes to the graph when both negative and positive values are introduced as the slope. (F-BF. 3)
3. Distinguish between linear and exponential functions.
4. Create equations with two or more variables; show relationships between quantities, graphs, and equations. (A-CED. 2)

CCSS Mathematical Practices:

1. Making sense of problems and persevere in solving them.
4. Model with mathematics.
5. Use appropriate tools strategically.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

CCSS Algebra Standards:

- F-IF.7: Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.
- F-BF. 3: Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$, $kf(x)$, $f(kx)$, 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 and explain the effects on the graph using technology.

- F-LE.1: Distinguish between situations that can be modeled with linear functions and with exponential functions.
- F-LE.1a: Prove that linear functions grow by equal differences over equal intervals, and that exponential functions grow by equal factors over equal intervals.
- A-CED. 2: Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.

Overview and Learning Activities

This unit is designed as an introduction to exponential functions. We assume that the students have a basic understanding of functions but a review and extended learning is needed.

1. Introduction to Exponential Functions (Inquiry Based):

Students will use the M&M activity where they will be required to conduct the activity in groups and answer various questions about their results. They will use previous knowledge and graphing calculators to compare/contrast different student results and explain why these differences exist while developing an understanding of the exponential equation.

Our goal with this activity is to introduce the exponential function to the class and see which students understand the basics of the exponential function and which students are struggling with the basic concepts of the function.

In this lesson students will collect their data and create a graph, equation, and then identifying what function they believe the information represents based off the data they acquired. Students will do this without teacher guidance to encourage student collaboration and to measure how much they know already about exponential functions.

Students will place their data and equation they created on the board and as a class we will discuss the collected data. Each group will then create a graph from the class data and find the domain and range as well as try to create an equation representing the class data both by hand and by using the graphing calculator. Once each group has created an equation and found the domain and range, as a class we will discuss each group's equation and the method they used to create their equation.

The teacher will work with the students to show them how this function arises from the context we are working in. This will allow us to see how they can apply knowledge they already know about creating a function equation and use it in a new situation. We will then proceed to name this function an *exponential function*.

The exit ticket will then be issued at the end of class where we will be asking the students what they know now and what they do not understand about exponential functions. This lesson is designed to spark interest in the exponential function. However, we do not anticipate that all students will have an understanding of exponential functions. This lesson is designed for one 50-minute class.

At the beginning of next class the teacher will walk through the M&M activity and show the students how to create an exponential function by hand by asking and then showing the students why the constant is the initial value, and why the base number is the common ratio from the context. The students will discuss how their data would change if they started with a different number of M&M's. This would help to promote a deeper understanding of what was originally being asked of the students.

2. Experimenting with Exponential Functions

During this lesson students will be experimenting with exponential functions through computer programs, their calculators and worksheets within their groups. Students will experiment with changing the base and initial value of exponential functions with the computer and the differences between an exponential function and a polynomial function. Students will work through the worksheet with some help from the teacher if needed. When the period is over, the teacher will go over worksheet with lots of interaction from the students.

Students will find that when they increase the initial value or the constant that the y -intercept will also increase. They will also find that when the base is less than one, the values found in regards to x will decrease and when the base is larger than one the values in regards to x will be increasing.

Duration: One 50-minute class period.

3. How to Interpret Exponential Functions from a Table of Values

Students will learn how to determine whether or not a table represents an exponential function by finding the deltas of the x and y values. Students will find that the delta for the x values are constant. Students will then discover that the y deltas are going to either increasing or decreasing from the given x value depending on whether it is a decreasing or increasing function. Students will then be able to find a common ratio. The goal is for the students to be able to discover and learn how to find the deltas and then realize that since there isn't a constant difference between y values, and then find the common ratio that will be the base number of an exponential equation.

Duration: One 50-minutes class period

4. Exploring Exponential Functions and Their Inverses

Using the modified student page “Exploring Exponential Functions and Their Inverses” on page 202 of *Teaching And Learning High School Mathematics* by Charlene E. Beckmann, Denisse R. Thompson, and Rheta N. Rubenstein, students will use *Geometer’s Sketchpad* to explore exponential functions. The students will compare relationships between graphs they have created on the program. The students will look the domain and range of a function, as well as steepness of their graph. This will be another way for them to see behaviors that exponential functions have. This activity focuses on $y = B^x$, which will led into the next lesson because the focus will be on $y = ab^x$.

Students will explore transformations of exponential functions through predictions that they will be making throughout the activity. They will look at what happens when the function is reflected over the line $y=x$. During this activity students will be able to see what more examples of what happened to the graph when B decreasing or when B is increasing.

Duration: One 50-minute class period.

5. Discovering Exponential Functions from Tables and Graphs (Problems in Context):

The use of problems that are applicable in the students’ life will be used after exploring with graphs and tables in the Problems in Context Activity. The students will be required to pick out important information from the problems given, which will require a more concrete understanding of exponential functions.

There are three different problems given to the students. One involves exponential growth equation regarding a tree frog population. This problem is a starting point to ease into the other two problems that require more analysis of the data. The *Cat in the Hat Comes Back* is an interactive activity where the story will be read to the class first. Many students would not think that a Dr. Seuss story would contain a math problem, however this will be a way to show how prominent math is around us. Finally, Marvel’s *The Avengers* problem shows exponential decay in a real- world situation. This requires an equation, and graph from a given table. This activity also has the students examine variables in an exponential function at a level, which is different from previous lessons.

Duration: Two 50-minute class periods.

6. Exponential Function Examples & Non-Examples (Card Sort):

This activity allows students to use everything they have learned about exponential functions in order to distinguish specific exponential functions from non-exponential functions. This activity requires students to have a deep understanding of exponential functions and what methods are used in order to determine they type of exponential function from a non-exponential function. There are five examples and five non-examples. Students will work together in order to sort each card. Once all of the students have sorted their cards, each group will write their solutions on the board and students will compare their results with the rest of the class. Any card that caused conflict will be worked through as a class. After this experience the students should then be able to describe *why* the non-example does not fit the exponential function criteria. By explaining more in-depth about their function we can work through any misconceptions that the students will have.

Duration: One 50-minute class period.

Materials Needed

1. Graphing calculator
2. *The Cat in the Hat Comes Back* by Dr. Seuss
3. M&M Activity worksheet, one per student
4. Cat in the Hat worksheet, one per student
5. Tree Frog worksheet, one per student
6. The Avengers worksheet, one per student
7. Exploring Exponential Functions and Their Inverses worksheet, one per student
8. Cards for Card Sort, one per group
9. Card sort answer key, one per student

Assessments

1. Daily Homework
2. Worksheets for each activity
3. Quizzes
4. Tests over the Unit
5. Exit Tickets

-We will require each student to fill out an exit ticket where they tell us what they learned from class and what they did not understand from each class period so we can see at what level the students are and where some students are lacking in knowledge of exponential functions.