Using Exponential Functions to Show the Impact New Technological Discoveries Have Had on Culture and Society

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This curriculum unit is recommended for: Math 1 Students

Keywords: Mathematics, exponential functions, exponential growth and decay, compound interest, technology, science, graph, data,

Teaching Standards: See Appendix 1 for teaching standards addressed in this unit.

Synopsis: In this unit, students will research, observe, analyze, and evaluate data that shows multiple trends in technology advancements over a period of about 471 years to present. The unit will start with The Scientific Revolution, which was the period that began the advancements of the technology outlined in this unit. This unit provides students with many cross-curricular connections. Students will learn about the history of the Scientific Revolution and technology, they will learn about scientific methods that enabled some of the technological innovations, they will learn about important scientist through many literature readings, and they will most importantly understand the mathematical concept of exponential functions through these many investigations the unit provides. Students will choose a current technological tool (e.g. telephone, cell phone, computer, and television) and research the connections this tool had to its historical equivalent during the era of The Scientific Revolution and beyond. The students will basically research the tool or service that was used back then to compensate for the current technology tools we have all been so accustomed to using now. Upon gathering the data the students will then look for any trends this tool has had in culture and society. The goal is for students to see an exponential growth in the current technology and notice an exponential decay in the previous technology. When this connection between growth and decay is made, the last portion of the unit will embed the financial aspect of the technology, compound interest, where students will have to determine the profit, expenses, interest rate, etc. of these technology tools. The concept of compound interest relates to the topic of exponential functions, because in order for the students to calculate profit, expenses, and interest rates, they must use an exponential function.

I plan to teach this unit to three blocks of 25-30 Math 1 9th grade students this current school year.
I give permission for the Institute to publish my curriculum unit and synopsis in print and online. I understand that I will be credited as the author of my work.

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Christian B. Lott

Introduction

Have you ever gone to dinner and noticed, either at your table or another guest's table, that at least one person was focused solely on a technological device--, perhaps a cell phone, tablet, or laptop? Or have you been guilty of this recent technological bad habit? Have you ever asked yourself, "What did I ever do before technology?" How did you connect with friends, media, news, or how did you ever get to your unfamiliar destinations without your GPS? With the continuous rise of technological advancements, we find ourselves questioning how we lived comfortably before technology. If you said yes to at least one question, this unit will be great to incorporate in your class because the students will be required to explore the history behind popular technological advancements. This research will begin in the 17th century with the Scientific Revolution moving to the 18th century during the Industrial Revolution and gradually move to present 21st century where technology is currently increasing rapidly.

The Scientific Revolution initiated a time of change in society and our understanding of nature through the emergence of mathematics, physics, biology, and chemistry. These developments paved the ways for many scientists to create prominent inventions that are now considered necessities in current society. This revolution was the beginning of the influence new advancements began to have on society and the lives of individuals. The Industrial Revolution, which occurred in the latter part of the eighteenth century, was an important transition in history to new technological developments.

This cross-curricular unit will integrate the use of math, science, literature history, and technology to show the rapid growth of technology and the impact this growth has had on society over the past years. The students will relate greatly to this unit because currently we reside in a so called "technology era"[1]where students consistently turn to technology before they pick up an encyclopedia or any other reference books. The purpose of this unit will be for the students to understand the methods people from the historic periods of the scientific revolution and industrial revolution used to communicate, entertain, and research information. They will also compare those methods to the current technology methods they currently use today and analyze the advancement those technologies went through from those historic periods.

To begin this unit, students will choose one of four main technology developments. These technology developments are:

1. Telephone
2. Cell phone
3. Computer
4. Television

After the topic has been chosen, the students will research the history of the technology in an effort to understand the advancements the specific technology went through from its initial invention to present. They also need to profile the previous instantiation of technology society used prior to the invention. For example, they need to find out how people communicated before the telephone was invented. Researching the instantiation of technology will show the high need and benefit of the technology. Also in the research, students must find valid quantitative data about the technology in terms of its advancement through history and the financial and personal benefits it played in society. The data can vary from product sales, product distribution, price of the product, etc. Upon gathering the data the students will represent the data graphically. This data, if gathered accurately, will show a pattern of exponential growth or exponential decay, thus reflecting the main math concept of the unit. The students will answer a series of questions related to their data and the technology. Taken together, the questions and the graphical representation will be formatted in a two to three page paper that will graded using a rubric (Appendix 3).

The final portion of the unit will be the use of a Problem Based Learning (PBL) task where students will act as problem solvers and reach an educated decision on the best bank account a company should choose, given certain parameters that will alter the rate of increase or decrease of the funds. Students will make the decision based on using Compound Interest, which is an important and relevant topic of the exponential function unit. The company discussed will directly correlate with the technology being researched (e.g. Samsung, Apple, Whirlpool, etc.). This PBL and synopsis of the report will be shared in class and great work will be displayed around the classroom.

Content Objectives

This curriculum unit is designed to be taught over a 2-week period. The main focus of this unit will be mathematics, but it will encompass science, literature, and history. This unit allows students to learn through engagement in a realistic problem[2]. This engagement is one of the key concepts of the Common Core Math standards because it shifts the students' focus from basic computation to mathematical understanding through solving real-world problems. Each of these core subjects plays a valuable role in connecting the topic of Exponential Functions to realistic applications, that all have to do with the rate of progress of certain technologies.

Science and technology play a valuable role in the creation of this unit, because science was used to create the technology the students will be researching, in order to

show the exponential growth or decay of the chosen technology tool. Scientists during the scientific revolution, industrial revolution, and beyond had a profound effect on the advancement of technology. The advancement of technology is the overlying factor of this curriculum unit, so understanding the scientists' effects on these advancements is essential for successfully completing the research project.

The literacy aspect of this unit allows the students to research the technology and find important information on the topic. I will have the students read non-fiction novels that relate to their technology so that they can comprehend the importance the technology has played historically and understand the advancements that accompanied the growth of the technology.

History is one of the most important subjects besides math entailed in this unit. For students to conceptually understand the importance of current technologies in society, they must understand the history of the technology. Students will research the history of the technology and also analyze the advancements and improvements it went through throughout the years. For example, a student may research the history of the telephone and find the advancements of the telephone such as the design of the telephone, the characteristics of the telephone, and the networking of the phone system.

While the students research the technology through those three core subjects, they will also be gathering valid quantitative data (the data generated must come from reliable sources) on the technology's advancements through history, so that they can construct a graphical representation of the data. This representation will be an exponential function and I will then provide scaffold questions and situations for the students to answer. I will ensure the data will be an exponential function because I will do prior research of the data of the four technology tools. I will then guide my students to the proper resources that will present the favorable results.

This unit is closely aligned to the Common Core State standards and the standards for mathematical practice. This unit relates the math concept of exponential functions to a familiar real-life topic, technology, and to the common core math standard's main objective is to have students understand math using realistic approaches. The eight standards for mathematical practices are closely related to the unit because each standard is used to gauge each student's learning on the task of exponential functions and application. Standard 1 (Make sense of problems and persevere in solving them) allows students to explain the meaning behind a problem and look for a solution. A Problem Based Learning (PBL) task will be used in the unit and students must become self-directed critical thinkers to solve the problem. To arrive at the solution the student must question and understand a variety of aspects of the problem.

Throughout the unit, students must identify the type of exponential function the technological data provided. The two types the data are: exponential growth; or

exponential decay. Depending on the trend of the data the students must predict the type and test their prediction by graphing the data points to observe the function. The graph can be constructed manually or by using the graphing calculator. These steps embed Standard 2 (Reason abstractly and quantitatively) and standard 5 (Using appropriate tools strategically). Standard 5 is also used when the students use resources (the encyclopedia, articles, journals, etc.) to find information on the technology. During this last component of the unit, the students will be given a variety of financial scenarios that relate to their technology and they must calculate the account balance of the company using a formula of compound interest. This concept relates to Exponential Functions because the formula of compound interest is an exponential function, that can illustrate exponential growth or exponential decay, depending on the interest rate. While completing the task, the students will be asked to help the company chose the right bank account so that they earn the most revenue in the shortest time. This action illustrates Standard 3 (Construct viable arguments and critique the reasoning's of others) because upon taking a stance on the right bank account, the students must justify their reasoning and if need be, defend their choice and question the choice of the other students.

Students will model the technology advancements on the past years using a graphical representation; this method supports Standard 4 (model with mathematics). While researching the technology to find data and history of the device, students must use reliable resources and must cite any work they use, this requirement attends to precision (Standard 6) because gathering the data must not cause any validity issues and must be accurate information. Throughout this unit, students will see an inverse correlation of the shapes of exponential growth functions and the shapes of exponential decay functions, while constructing these graphs correctly the students will initially know the type of exponential function based solely off the shape of the graph. Observing any patterns supports standard 7 (look for and make use of structure). In addition to observing patterns in the graphical representations of exponential functions, the type of exponential function can also be identified through the exponential equations. If the rate of change of the exponential function is greater than one, then the function is exponential growth, consequently, if the rate of change is greater than zero but less than one, then the function represents exponential decay. This constant trend allows the students to make predications about the type of exponential function the data of the technology possess, which embeds standard 8 (look for and express regularity in repeated reasoning).

Problem based learning (PBL) is an approach that challenges students to learn through engagement in a real problem[3]. The entire unit is surrounded by a realistic situation, so encompassing PBL is a great fit for students to make stronger connections to the content. PBLs allow the students to take responsibility for their learning and understanding which allows them to be more of a self directed learner. PBLs but uses appropriate problems to increase knowledge and understanding[4] of the content. The PBL task will highlight the key features learned through realistic and relevant applications and

serve as a means of assessing the content attainment of the students prior to a more formative assessment.

As with any PBL task I will first introduce the initial part of the task and then go through each section so that students are aware of what must be done. Following the brief introduction, I will assign the students to "strategic groups" and allow them to become the problem solvers of the task. I will then gain the class attention to go over the scaffold questions to guide them to the solution and to make sure they understand the relevance of the task and how it relates to the content of exponential functions. It is very important that students have realistic problems to relate to because, having a context for the knowledge, helps the students retain the class content. It is also important for the students to understand the rationale behind what is being asked of them and how they arrived at their solution. Doing this makes the connection more profound and students will be more willing to the give their best effort.

Background

I am a ninth grade REACH Math 1 teacher in a large urban Title 1 high school in Charlotte, North Carolina. My Charlotte Mecklenburg School consists of about 70% African American students and about 71% of students qualify for free/reduce lunch.

The REACH Model is a form of Blended Learning where students spend approximately 25%–50% of their in-school time engaged in personalized digital learning. The remaining of the in-school time will consist of excellent in-person whole group and lecture instruction by the teacher. Students rotate on a fixed schedule between digital instruction and face-to-face learning with the teacher. This extra time allows excellent teachers to use free time to teach additional classes, focusing primarily on personalized and enriched portions of instruction. During the digital learning time, REACH Associates (similar to a teacher associate) will supervise students, and tutor students individually and in small groups.

I teach three sections of REACH Math 1 where each class averages about 28 students per block. Although my school is considered low-income and my students are labeled as economically disadvantaged, they still have access to social media sites and the technology they require. One hundred percent of my students have cell phones and about 80 % of them have smart phones. Although my students do not come to school prepared with their basic classroom supplies, they do however; have means to the newly innovative devices (cell phones, laptops, computes, and tablets) that have popular social media applications, in which the majority of my students are members of. Although they are considered low-income these students (or their families) find the means to purchase the things they desire and see that are important.

Race and social class play a little role in terms of access beyond the

> aforementioned disenfranchised population. Poor urban black teens appear to be just as likely to join the site as white teens from wealthier backgrounds, although what they do on there has much to do with their level of Internet access.[5]

During the beginning of the school year, as an icebreaker, I gave my students a profile sheet that asked several questions so that I could learn more about them. One question that I asked on the sheet was: "What do you do when you have free time?" About 85% of my students stated that they talk on their phone, watch television, or use the computer. Noticing the high influence technology has on my students, this unit will impact them greatly.

My focus is not to eliminate the use of technology my students have grown so accustomed to, but it is to educate them about the benefits of technology. I want my students to use the technology to the best of their abilities, so during this unit technology will be used greatly due to the REACH model's rationale. Given the prevalence of technology, I predict that my students will take at least one online class while in college, whether synchronous or asynchronous. My prediction has also been supported heavily by research, because online education has increased drastically over the few years and students should be prepared for further increase that may begin as early as next year, especially with this implementation of blended learning at my school.

> Nationally, the number of students taking at least one online course is now over two million, with over 2.3 million total students in fall 2004. Overall online enrollment increased from 1,971,397 in fall 2003 to 2,329,783 for fall 2004. The number of new students added to those studying online matched the number added for the previous year (around 360,000 in both cases). Students at colleges and universities in the southern states represent 29% of online enrollments, with 672,000 students taking at least one online course.[6]

Given this substantially high data as well as the progression technology has made, preparing my students for post-secondary education, where they may have to potentially use technology to receive instruction, is very important to me. This curriculum unit will prepare the student to use technology more in education, and it will allow them to see the benefits technology has on their lives and in education

Teaching Strategies

Introductory Activities

What Are Exponential Functions?

Before we can dive in this unit, students must be familiar with the definition of exponential functions and the many forms in which they appear. I will begin this

introduction with a blended learning technique, where the high-flyer students will watch an online lesson on exponential functions and the remaining students will have direct teacher instruction. The lesson will define exponential functions and illustrate the different representations by which these functions can be expressed (equations, graphs, and tables). Students must recognize exponential growth and decay specifically while viewing graphs and equations.

Understanding these forms of representation is essential for students in order to be successful in analyzing the data they gather, so that they can correctly identify the type of function and also identify important characteristics of the function. After the blended instructional lessons, students will practice solving, graphing, and interpreting different exponential functions. They will also compare and contrast the different functions present in Math 1 (linear functions and quadratic functions). This will help students to identify the type of function they come across in their research.

Research Methods

The next component will introduce students to the proper research techniques. They will learn how to research a topic using multiple sources. Students are currently familiar with popular search engines, such as Google, Yahoo, and Bing. There are however, other resources such as encyclopedias, nonfiction books, scholarly articles, and journals, newspapers, etc. that are more reliable than the typical online resources. I will use part of class to discuss the acceptable resources and the proper search engines to use in their research. I then will use the rest of the time to take the class to the library where the librarian will show the students how to use the unfamiliar resources to conduct valid research.

Comprehension Activities

For students to conceptually understand the definition of exponential functions and the types of this function, growth and decay, a common graphic organizer called a Frayer Model is a necessary strategy to use in order to build comprehension. A Frayer Model is a type of graphic organizer that "provides a visual representation of how the brain organizes its information: The graphic organizer presents significant concepts and the attendant relationship indicates that graphic organizers are especially effective for teaching technical vocabulary."[7] Students will use Frayer Models to conceptually depict exponential functions from other functions discussed in Math 1 (linear and quadratic functions). The Frayer Model will also help students comprehend the different exponential functions (growth and decay) and be able to recognize each type in different representations (equations, graph, table, and words).

Conceptualizing Activities

A Problem Based Learning (PBL) task is an instructional strategy where students will learn through facilitated problem solving where they must conceptualize the problem in order to reach a solution. In mathematics it is essential for students to conceptually understand not only the steps to arrive at the accurate solution, but the rationale in why they performed those steps. The best ways for students to learn conceptually is through experience, where the students actually complete the task and arrive at a solution. "Psychological research and theory suggest that by having students learn through experience of solving problems, they can learn both content and thinking strategies."[8] This theory is the cornerstone of North Carolina's Common Core Math strategies and standards. Once students have researched their technological topic and derived a detailed report, the next component will be the PBL task, which will use real-life information related to the technology aspect of this unit, to solve a problem. This PBL task will allow students to develop 1) flexible knowledge about exponential functions; 2) effective problem-solving skills; 3) self-directed learning skills; 4) effective collaboration skills; and 5) intrinsic motivation. These five components are essential for students to possess high academic growth in math, which will make them successful in mathematics.

Social Skill & Team Building Activities

Cooperative-Learning is a strategy where students work in a group to complete tasks. The purpose of cooperative learning is promoting social experiences through an academic task. The students are evaluated on their ability to work as a group, as they progress toward a solution. According to Rock and Brumbaugh, cooperative learning generates positive results in areas of: academic achievement, self-esteem or self-confidence in learning, intergroup relations, including cross-race and cross cultural friendships, social acceptance of mainstreamed children, and ability to use social skills. [9] In setting up cooperative groups one must take in consideration four main decisions. Roger and David Johnson suggest that:

> *1) Students achieve more in cooperative interaction than in competitive or individualistic interaction. The results indicated that cooperation seems to be much more powerful in producing achievement than the other interaction patterns and the results hold for several subject areas and a range of age groups from elementary school through adult.*
>
> *2) Students are more positive about school, subject areas, and teachers or professors when they are structured to work cooperatively.*
>
> *3) Students are more positive about each other when they learn cooperatively than when they learn alone, competitively, or individualistically - regardless of differences in ability, ethnic background, handicapped or not.*

4) Students are more effective interpersonally as a result of working cooperatively than when they work alone, competitively or individualistically. Students with cooperative experiences are more able to take the perspective of others, are more positive about taking part in controversy, have better developed interaction skills, and have a more positive expectation about working with others than students from competitive or individualistic settings. [10]

Classroom Activities

Activity #1 Exponential Functions Lesson: Days 1 – 3

The introductory portion of the unit will be the instructional aspect. Utilizing the blended learning techniques, students will be chosen to receive either online instruction or direct teacher instruction based on their previous assessment data. Students who scored at or above average would receive online instruction because their math ability will allow them to have more self-directed instruction without experiencing any issues. The below level students will have direct teacher instruction because this will allow me to tier and differentiate my instruction to ensure I am meeting the needs of those students.

Day 1: Introduction to Exponential Functions

This lesson will focus solely on familiarizing students with exponential functions. By this point in their education students should be able to identify linear functions, and should be able to recognize quadratic functions, so to alleviate any confusion, exponential functions should be explained as an introductory lesson, where characteristics are outlined.

The lesson will identify the definition of exponential functions, the representations of exponential functions, and the properties of exponential functions. To facilitate in the students learning, whether they are online learning or teacher led learning, guided notes will be provided so relevant information can be organized effective in one document. The man topics of Day 1's lesson are:

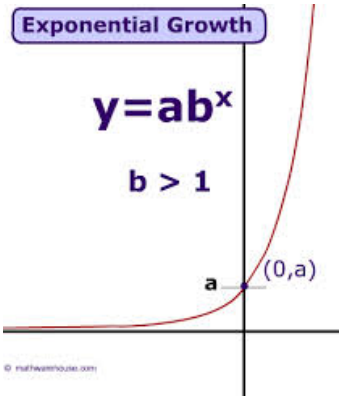
1. Definition of Exponential Functions
2. Representations of Exponential Functions
    a. Equation
    b. Graph
    c. Table

Day 2: Exponential Growth and Decay

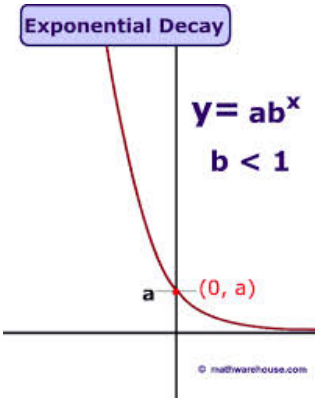
These two types of exponential functions are important components because each type has a different role and outcome. Exponential growth is a function that increases while exponential decay is a function that decreases. Students are expected to identify these exponential functions through:

1. Graphs

Exponential Growth



Exponential Decay



2. Equations

Exponential Growth

$$y = a(1-r)^t$$

Exponential Decay

$$y = a(1-r)^t$$

3. Tables

Exponential Growth

x	y
0	2
1	4
2	8
3	16

Exponential Decay

x	y
1	16
2	4
3	1
4	1/4

4. Word Problems

Exponential Growth

A certain type of bacteria, given a favorable growth medium, doubles in population every 6.5 hours. Given that there were approximately 100 bacteria to start with, how many bacteria will there be in a day and a half?

Exponential Decay

The number of pandas in the world is decreasing at a rate of about 0.5% every year. If in one year there are 3000 pandas in the world, how many will there be in 4 years?

Day 3: Compound Interest

Compound interest is interest that is paid on both principal and interest from past years. The formula to calculate compound interest is an exponential function:

$$A = P(1 + \frac{r}{n})^{nt}$$

a) Where A is the ending amount
b) P is the beginning (principal) amount
c) r is the interest rate (in terms of a decimal)
d) n is the number of compounding years
    a. n = 1 when it is compounded annually
    b. n = 2 when it is compounded semi-annually
    c. n = 4 when it is compounded quarterly
    d. n = 12 when it is compounded monthly

This lesson plays a valuable part in the real-world application piece that will be using in the PBL task on Days 8 and 9.

Activity #2 Technology Research Project Days 4 - 7

The project will outline the role exponential functions plays in the real world and in history. Students will have to find valid information on a technological advancement and research its history, improvements, as well a gathering data regarding the product (sales, usage, demand, supply, etc.) over a period of time. Based on the data, students will construct a graphical representation and identify the type of function. To conclude the research, students will compile all information in a report followed by answers to a few questions, where they reflect and make connections of the technological advancements to exponential functions. The report will be graded using a detailed rubric (Appendix 3).

Day 4: Project Introduction and Instructions on Proper Research Sources

Students will be introduced to the project and informed of the adequate research techniques. Students will take a trip to the school library with the librarian will show the students how to use certain resources to find valid information. Student resources such as novels, articles, and newspapers will be provided for the students to utilize during their research process.

Day 5: Choose Topic and Begin Research

Students will choose a technological advancement from the list below and will collectively meet in their technology groups. In the group meetings, students will discuss known information on the technology and begin researching more prevalent information.

Technology Topics

1. Telephone
2. Cell phone
3. Computer
4. Television

Day 6: Research Continues and Data Collection

Time will be given in class for students to continue researching the technology topics, however research outside of class is required. Students will also begin gathering valid data to begin forming the graphical representations.

Day 7: Final Touches

Students should, by now have gathered all necessary information and data, so this day is set aside specifically to allow students to begin typing the information and answering the follow up questions. The final report will be due the next class.

Activity 3 Problem Based Learning (PBL) Task: Days 8 and 9

The final component of the unit is the PBL task (Appendix 4) where students will use information from Day 3's lesson and information from the research project to solve a problem. The PBL task is instructional approaches, which will help the students develop an understanding of exponential functions.

Day 8: PBL Introduction

Students will be divided into cooperative groups of four and given the PBL task. Each group member will have a role:

1. **Leader/Editor:** This student is in charge of organizing the final product of the project, be it a paper, a presentation, etc. That doesn't mean that he/she is responsible for technical details, but in making sure that the project meets the standards set out by the instructor (often as a rubric); it also includes any extras stipulated by the group. These standards generally include punctuality and completeness.
2. **Recorder/Secretary:** This person takes notes whenever the group meets and keeps track of group data/sources/etc. This person distributes these notes to the rest of the group highlighting sections relevant for their parts of the project.
3. **Checker:** This individual will double-check data, bibliographic sources, or graphics for accuracy and correctness.
4. **Spokesperson/Press Secretary/Webmaster:** This person will be responsible for the technical details of the final product and will be ready

to summarize the group's progress and findings to the instructor and to other groups.

Day 9: Presentations of PBL

The cooperative groups will finalize the PBL and organize the information into a creative display for their presentations. The groups will be graded based on the PBL task itself and the Presentation while each student will be graded on their role in the groups. Doing this makes each person accountable for his or her grade, so that equal effort is put forth.

Appendix 1: Implementing Teaching Standards

Standard 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.

a. Graph exponential functions, showing intercepts and end behavior

This standard is used during the time the students have to graphically represent the data gathered on the technology they chose. The key features of the graph will allow the students to depict this representation as an exponential function that changes at a rapid pace. Students must possess knowledge on how to properly graph functions and how to properly identify the type of function that was graphed.

Standard F.IF.9: Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).

When the students must identify the type of function illustrated from the graph, this thoroughly shows the standard, because correctly identifying the function from the graph will allow connections of exponential functions and it's properties to be made.

Standard F.LE.1: Distinguish between situations that can be modeled with exponential functions.

a. Prove that exponential functions grow by equal factors over equal intervals
b. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another

The final portion of the curriculum unit is the Problem Based Task, where students become problem solvers, in finding the best savings account for a business to use. To accurately find the solution of this task, the students will have to use the Compound Interest Formula to calculate the amount of money the business will have after an amount of time, with a fixed interest rate, and the compounding frequency. This activity will allow the students to identify and recognize a situation that shows an exponential growth or decay and make connections to this real world and the math content.

Standard F.LE.3: Observe, using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly.

The entire unit stresses the comparison of exponential functions to linear functions. Students are accustomed to linear functions, but during this unit they need to be able to identify exponential functions through the many representations (graphs, tables, and equations). When students gather data and represent it graphically this standard will be used to show the students' understanding of exponential functions and how it differs from linear functions

Appendix 2: Technological Advancements Research Paper

Name:_____ Due Date:_____

A Glance in History: Illustrating the Correlation of Technology Advancements Using Mathematics

Task: You are to choose ONE technology tool listed below and:

- Research the history of the technology
- Research the advancements of the technology
- Gather relevant QUANTITATIVE data on the technology
    - Once data has been gathered, this data must be illustrated graphically
- Determine the type of function the data illustrated
- Answer the Reflective Questions (See Below)

Choose ONE of the four technology tools to research

1. Telephone
2. Cell phone
3. Computer
4. Television

Requirements: Your paper should be between 3 – 5 pages, including graphs and resources. The paper should be Times New Roman, 12pt font, double-spaced, and with 1 inch margins. Include a resource page at the end of the paper, cited in APA format (this is NOT a part of your 3 – 5 pages). All components from the task must be embedded in the paper, use your judgment in how you choose to organize them in your paper. When submitting your paper, the rubric MUST be attached to the last page (this is NOT a part of your 3 – 5 pages). Make sure you proofread your paper, because grammar will be evaluated.

Reflective Questions:

1. What trend, if any, did you notice with the data you collected?
2. How do you think the technology advancements benefited society since the Scientific Revolution? Be specific.
3. Summarize the relationship this assignment has to mathematics, science, literature, and history.
4. In completing this assignment do you think your ideas of technology have changed? If so, how did they change? Provide examples.

Appendix 3: Technological Advancements Report Rubric

	Excellent *(10-9 points)*	**Above Average** *(8-6 points)*	**Average** *(5-3 points)*	**Unsatisfactory** *(2-0 points)*	**Total**
Research Paper Format	Research paper has a minimum of three (3) pages of text; 12 point font; Times new roman; Double space; and one inch margins	Research paper has three (3) pages of text; and some of the page set-up (12 point font; Times new roman; Double space; and one inch margins)	Research paper has two (2) pages of text; and some of the page set-up (12 point font; Times new roman; Double space; and one inch margins)	Research paper has minimal pages of text; and some of the page set-up (12 point font; Times new roman; Double space; and one inch margins)	
Mechanics	All sentences are well constructed and have varied structure and length. The author makes no errors in grammar, mechanics, and/or spelling.	Most sentences are well constructed and have varied structure and length. The author makes a few errors in grammar, mechanics, and/or spelling, but they do not interfere with understanding.	Most sentences are well constructed, but they have a similar structure and/or length. The author makes several errors in grammar, mechanics, and/or spelling that interfere with understanding.	Sentences sound awkward, are distractingly repetitive, or are difficult to understand. The author makes numerous errors in grammar, mechanics, and/or spelling that interfere with understanding.	
Overall Research Paper	Research paper clearly explained the technology and showed evidence of background research. Organized and presented data clearly, using graphs. Reflective Questions answered clearly and accurately.	Research paper clearly explained the technology and showed some evidence of background research. Some organization and presentation of data clearly, using graphs. Most of the Reflective Questions were answered clearly and accurately. Most information was researched	Research paper did not clearly explain the technology and showed little evidence of background research. Little organization and presentation of data, using graphs. Some of the Reflective Questions were answered clearly and accurately. Some of the	Research paper did not clearly explain the technology. Showed no evidence of background research. Unorganized and data presented unclearly, not using graphs. Reflective Questions were not answered clearly or accurately.	

	All information was researched prior to the research deadline. All information provided in the research paper was cited accurately.	prior to the research deadline. Most of the information provided in the research paper was cited accurately.	information was researched prior to the research deadline. Some of the information provided in the research paper was cited accurately.	Minimal information was researched prior to the research deadline. Little to no citations.	
Final Score					

**Please note <u>Mechanics</u> is greyed; pay close attention to this area. At times we fail to take grammar into consideration in mathematics.*

Appendix 4: Comparing Investments Problem Based Task

Goal: The goal is to use compound interest formulas to investigate and compare savings situations while using your writing skills to clearly communicate the solution.

Role:
You and your group members are the financial consultants for a new business who specializes in technology restoration, and they are in need of your expert financial advice.

Situation:
In this recession, everyone is looking to earn the most they can on their income. You all have been hired as financial consultants to help businesses determine the best options for their investment plans. Utilizing your compound interest skills, you need to convince the new business owners of the best option for their savings.

Scenario:
You Break It, We Fix It Inc., technology restoration company wishes to invest in a savings account. They currently have $65,000 in an account bearing $5\frac{1}{4}$ % annual interest, compounded continuously. The following options are available to them:

i. keep the money in the account they currently have
ii. invest the money in an account bearing $5\frac{7}{8}$ % annual interest, compounded annually
iii. invest the money in an account bearing $5\frac{1}{2}$ % annual interest, compounded quarterly

a. Determine the equation for the value for the investment as a function of time for each of the three options.

b. Graph all three functions on the same coordinate plane so each graph is distinguishable. Be sure to label all information.

c. The company is hoping to have $90,000 saved for a down payment on a new location within six years. Write a brief summary to the company that describes the implications of these options.

d. The *effective yield* of a savings plan is the percent increase in the balance after 1 year. Find the effective yields for the three options listed above. How can the effective yield be used to decide which option is best?

e. Your presentation should be in booklet form to turn in including but not limited to:

1. a letter of proposal referencing each option
2. calculations for each situation
3. graphs of the three situations

f. Your official presentation to the class can be as creative as you all want.

Appendix 5: Comparing Investments Problem Based Task Rubric

Group Member Roles:

Leader:_____

Secretary:_____

Checker:_____

Spokesperson:_____

Rubric Rating Scale:

	Not Demonstrated	Proficient	Accomplished
Teamwork 50 pts.	Team did not collaborate well. Work was not distributed evenly. Some members did more work than others. Serious issues arose.	The team worked well together. There was some lack of communication that caused minor issues.	The team worked very well together to achieve the goal of finding the best solution to the problem. All work was distributed evenly and there was 100% participation.
Contribution 25 pts.	Did little to no contribution to the project. Other members had to complete your portion.	Contributed to majority of work, however some components of work were not acceptable or omitted.	Contribution was very useful to generating the solution of the PBL. At times you went above and beyond expectations.
Presentation 25 pts.	Demonstrated little to no knowledge of presentation guidelines and content of the PBL.	The delivery of presentation was organized, despite some errors or issues.	The delivery was organized and content was clearly explained. Diagrams were very presentable.
Total (100 pts.)			

Notes

[1] "How Does Technology Affect Teens?" Teen Ink. Accessed October 11, 2014. http://www.teenink.com/hot_topics/what_matters/article/289625/How-Does-Technology-Affect-Teens/.

[2] "Problem Based Learning Description." Problem Based Learning Description. Accessed October 11, 2014. http://online.sfsu.edu/rpurser/revised/pages/problem.htm.

[3] Hmelo-Silver, Cindy E. "Problem-based learning: What and How Do Students Learn?" *Educational Psychology Review* 16, no. 3 (2004): 235-66.

[4]Wood, Diana F. "Problem Based Learning." *Bmj* 326, no. 7384 (2003): 328-30.

[5]Boyd, Danah. "Why Youth (heart) Social Network Sites: The Role of Networked Publics in Teenage Social Life." *MacArthur Foundation Series on Digital Learning–Youth, Identity, and Digital Media Volume* (2007): 119-42.

[6]Allen, I. Elaine, and Jeff Seaman. "Growing by Degrees: Online education in the United States, 2005." *Sloan Consortium (NJ1)* (2006).

[7] Monroe, Eula Ewing, and Michelle R. Pendergrass. "Effects of Mathematical Vocabulary Instruction on Fourth Grade Students." (1997).

[8] Hmelo-Silver, Cindy E. "Problem-based learning: What and How Do Students Learn?" *Educational Psychology Review* 16, no. 3 (2004): 235-66.

[9] Brumbaugh, Douglas K., and David Rock. *Teaching Secondary Mathematics*. 2nd ed. Mahwah, N.J.: Lawrence Erlbaum, 2001.

[10] Johnson, David W., and Roger T. Johnson. *Active Learning: Cooperation in the College Classroom*. Edina, MN: Interaction Book, 1991.

Student Resources

http://www.conferencecallsunlimited.com/history-of-communication-technology/
This resource will allow students to gather information on the history of communication technology, such as: telephone and the cellphone.

http://www3.northern.edu/wild/th100/tv.htm
Students will use this resource to find information on the history of television.

http://www.computerhistory.org/timeline/?category=cmptr
This resource shows a timeline of the development of computers.

http://www.technologyreview.com/news/427787/are-smart-phones-spreading-faster-than-any-technology-in-human-history/
This site shows data on the advancement of the smartphone.

http://www.studyzone.org/testprep/ss5/b/ecotech20l.cfm
This sites gives information on the advancement of some technologies.

www.prezi.com
This website is an interactive presentation site that students can use to present their Problem Based Task.

www.glogster.com
This site is an online blog that students can use to present their Problem Based Task.

Levinson, Paul. Cell phone : The Story of the World's Most Mobile Medium and How It Has Transformed Everything!. Gordonsville, VA, USA: Palgrave Macmillan, 2004. Accessed October 29, 2014. ProQuest ebrary.
This eBook discusses the transformation of the cell phone

Teacher Resources

http://www.loc.gov/teachers/usingprimarysources/
This resource is helpful for teachers to use so they can instruct students on how to use adequate primary sources.

Schmidt, Hendricus Gerard. "Problem□based learning: Rationale and description." *Medical education* 17, no. 1 (1983): 11-16.
This resource is helpful for teachers to use to familiarize themselves with this instructional strategy.

Bibliography

Allen, I. Elaine, and Jeff Seaman. "Growing by degrees: Online education in the United States, 2005." *Sloan Consortium (NJ1)* (2006). This article outlines significant data for teachers to show the importance of how online education is drastically advancing and how it can effect students in the near future.

Boyd, Danah. "Why Youth (heart) Social Network Sites: The Role of Networked Publics in Teenage Social Life." *MacArthur Foundation Series on Digital Learning–Youth, Identity, and Digital Media Volume* (2007): 119-42. This online site provides teachers and students with insights and history of social media and how and why it became so popular over the recent years. Data was presented to support the claims made throughout the article.

Brumbaugh, Douglas K., and David Rock. *Teaching Secondary Mathematics*. 2nd ed. Mahwah, N.J.: Lawrence Erlbaum, 2001. This book provides teachers with very useful strategies, such as cooperative learning, and more, to make instruction more interactive and engaging.

Dunlap, William P., and Martha Brown McKnight. "Vocabulary Translations for Conceptualizing Math Word Problems." *The Reading Teacher,* no. 2 (1978): 183-89. This journal article outlines strategies that are useful for math teachers to help students with math vocabulary. One strategy this article discusses is the Frayer model.

Hanna, Gila. "Evaluating research papers in mathematics education." In *Mathematics education as a research domain: A search for identity*, pp. 399-407. Springer Netherlands, 1998. Because students have to write a research paper, and research papers in mathematics is not common, this article helps the teacher learn how to properly evaluate and analyze math papers. It also provides teachers with ideas on how to present the topics and rubrics.

Hmelo-Silver, Cindy E. "Problem-based learning: What and How Do Students Learn?" *Educational Psychology Review* 16, no. 3 (2004): 235-66. This article is essential for teachers in implementing problem-based learning in their classrooms. It defines this instructional strategy, outlines how to structure it, and the benefits problem-based learning benefits the students.

"How Does Technology Affect Teens?" Teen Ink. Accessed October 11, 2014. http://www.teenink.com/hot_topics/what_matters/article/289625/How-Does-Technology-Affect-Teens/. This blog is useful to understand the effects technology plays on students. Teachers can use this resource to gain ideas and thoughts of teens, to fully understand, their thoughts on how technology affect their lives.

Johnson, David W., and Roger T. Johnson. *Active Learning: Cooperation in the College Classroom*. Edina, MN: Interaction Book, 1991. This book allows the teacher to learn about the benefits of cooperative learning. The teacher can learn how to group students accordingly, how to make all students accountable, and how to make cooperative learning engageing and effective.

Johnson, Roger T., and David W. Johnson. "Cooperative Learning Two Heads Learn Better than One." *Transforming Education*, 1988, 34.
Kelly, Martin, and William Aspray. *Computer: A History of the Information Machine*. New York: Basic Books, 1996. This book also provides teachers with valuable information on the benefits of cooperative learning and the process a teacher can go about creating cooperative learning groups.

Monroe, Eula Ewing, and Michelle R. Pendergrass. "Effects of Mathematical Vocabulary Instruction on Fourth Grade Students." (1997). This journal article allows the teacher to explore many strategies that helps students learn math vocabulary in different ways. It also instills the importance of how math vocabulary builds conceptual understanding of the math content.

"Problem Based Learning Description." Problem Based Learning Description. Accessed October 11, 2014. http://online.sfsu.edu/rpurser/revised/pages/problem.htm. This website thoroughly describes problem-based learning and how it can be used in a classroom. A teacher can use this resource to develop this strategy in his or her class to engage students and make them more self-directed learners.

Vithal, Renuka, and Alan J. Bishop. "Mathematical Literacy: A New Literacy or a New Mathematics?" *Pythagoras*, 2006. This resource allows teachers to learn new literacy strategies that can be use in mathematics. These strategies will allow students to retain the content better, so they can be more successful with the material.

Wood, Diana F. "Problem Based Learning." *Bmj* 326, no. 7384 (2003): 328-30. This is another resource that outlines the basis of problem-based learning and how teachers can utilize this strategy in his or her classroom to make instruction more relevant and give students more autonomy in the classroom.