Unit 3: Exponential Models and Relationships

Content Area: **Mathematics**
Course(s):   **Algebra 1**
Time Period: **Generic Time Period**
Length: **14 Weeks**
Status: **Published**

Unit Overview

This unit opens with a study of exponential expressions and functions. Students will extend their understing of the properties of exponents to working with rational exponents. They will then move on to study exponential functions--graphing, writing, and applying these functions to real world situations. Following this, students will briefly review writing and graphing both linear and quadratic functions in preparation for bringing together linear, quadratic and exponential models. Great emphasis will be placed on comparing these models and applying them to describing real world situations and answering real world questions. At the conclusion of the unit, students will learn to perform basic operations on radical expressions.

By the end of June, administer the Linkit! Algebra I NJSLS Form C TEI AG

Transfer

Students will be able to independently use their learning to...

- Relate algebraic terminology to real life problems/applications.
- Apply content to relevant situations that occur both inside and outside of their math classes.

For more information, read the following article by Grant Wiggins.

http://www.authenticeducation.org/ae_bigideas/article.lasso?artid=60

Meaning

Understandings

Students will understand that...

- Critical vocabulary is necessary to communicate and understand mathematics in the real world.
- The symbolic language of algebra is used to communicate, analyze, and generalize patterns.
- Algebraic relationships can be represented graphically, numerically, symbolically, or verbally.
- In mathematical relationships, the value for one quantity depends on the value of another quantity.
- Non-linear change can be represented by graphs, mathematical models, and equations.
- Algebraic models are useful in describing real-life situations.
- Exponents change the shape of a graph.
- Exponents apply to real-world situations.
- Linear, Quadratic, and Exponential Functions can be applied to real-world situations.

Essential Questions

Students will keep considering...

- How do mathematical ideas interconnect and build on one another to produce a coherent whole?
- How can critical vocabulary terms be used to better enhance the understanding of mathematics?
- How can patterns, relations, and functions be used as tools to best describe and help explain real-life situations?
- How can functions be used as tools to best describe and help explain real-life situations?
- How does the value of one variable affect the value of another variable?
- How can mathematical language be used to describe non-linear change?
- How do exponents change the shape of a graph?
- How can linear, quadratic, and exponential functions be applied to real-world situations?

Application of Knowledge and Skill

Students will know...

Students will know...

- The properties of exponents.
- What linear, quadratic, and exponential functions look like.
- How to interpret the key features of linear, quadratic, and exponential functions.
- What kinds of situations are best represented by linear, quadratic, and exponential models.

Students will be skilled at...

- Simplifying exponential expressions.
- Graphing exponential functions.
- Determining when a given situation can be best represented by a linear, quadratic, or exponential model.
- Writing linear, quadratic, and exponential models to describe given information.
- Interpreting the parts of linear, quadratic, and exponential models.
- Using linear, quadratic, and exponential models to answer real world questions.
- Performing basic operations on radical expressions.

Academic Vocabulary

parent function	maximum	minimum	domain	range	data sets	radical expressions
increasing	decreasing	exponents	product rule	power rule	models	quadratic functions
quoitent rule	zero exponents	negative exponents	rational exponents	exponential functions	linear functions	properties of exponents

Learning Goal 3.1: Properties of Exponents

- SWBAT simplify and evaluate exponential expressions.

| MA.8.EE.A | Work with radicals and integer exponents. |
| MA.N-RN.A | Extend the properties of exponents to rational exponents. |

Target 3.1.1 - Properties of Exponents

- SWBAT recall properties of exponents, such as the product rule, power rule, quotient rule, etc. (DOK: 1 - Retrieval)

MA.8.EE.A.1	Know and apply the properties of integer exponents to generate equivalent numerical expressions.
MA.K-12.1	Make sense of problems and persevere in solving them.
MA.K-12.2	Reason abstractly and quantitatively.
MA.K-12.5	Use appropriate tools strategically.
MA.K-12.6	Attend to precision.
MA.K-12.8	Look for and express regularity in repeated reasoning.

Target 3.1.2 - Exponential Expressions

- SWBAT simplify and evaluate expressions containing zero and integer exponents. (DOK: 2 - Comprehension)

MA.8.EE.A.1	Know and apply the properties of integer exponents to generate equivalent numerical expressions.
MA.K-12.1	Make sense of problems and persevere in solving them.
MA.K-12.2	Reason abstractly and quantitatively.
MA.K-12.3	Construct viable arguments and critique the reasoning of others.
MA.K-12.4	Model with mathematics.
MA.K-12.5	Use appropriate tools strategically.
MA.K-12.6	Attend to precision.
MA.K-12.7	Look for and make use of structure.

Target 3.1.3 - Rational Exponents

- SWBAT evaluate and simplify expressions containing rational exponents. (DOK: 2 - Comprehension)

MA.8.EE.A	Work with radicals and integer exponents.
MA.8.EE.A.1	Know and apply the properties of integer exponents to generate equivalent numerical expressions.
MA.K-12.1	Make sense of problems and persevere in solving them.
MA.K-12.2	Reason abstractly and quantitatively.
MA.K-12.3	Construct viable arguments and critique the reasoning of others.
MA.K-12.4	Model with mathematics.
MA.K-12.5	Use appropriate tools strategically.
MA.K-12.8	Look for and express regularity in repeated reasoning.
MA.N-RN.A	Extend the properties of exponents to rational exponents.
MA.N-RN.A.1	Explain how the definition of the meaning of rational exponents follows from extending the properties of integer exponents to those values, allowing for a notation for radicals in terms of rational exponents.
MA.N-RN.A.2	Rewrite expressions involving radicals and rational exponents using the properties of exponents.

Learning Goal 3.2: Exponential Functions

- SWBAT identify key features of exponential functions and apply them to real-world situations.

MA.F-LE.A	Construct and compare linear and exponential models and solve problems

Target 3.2.1 - Graphing Exponential Functions

- SWBAT graph exponential functions. (DOK: 2 - Comprehension)

MA.K-12.6	Attend to precision.
MA.K-12.7	Look for and make use of structure.
MA.A-REI.D.10	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).

Target 3.3.2 - Interpreting Exponential Functions

- SWBAT explain the meaning of each term in an exponential function and relate the equation of the function to its graph. (DOK: 2 - Comprehension)

MA.F-IF.B.4	For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship.
MA.K-12.1	Make sense of problems and persevere in solving them.
MA.K-12.7	Look for and make use of structure.

Target 3.2.3 - Writing Exponential Functions

- Given a graph or table of values, SWBAT write an exponential function. (DOK: 2 - Comprehension)

MA.F-BF.A.1	Write a function that describes a relationship between two quantities.
MA.F-BF.A.1a	Determine an explicit expression, a recursive process, or steps for calculation from a context.
MA.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).
MA.K-12.4	Model with mathematics.
MA.K-12.6	Attend to precision.
MA.K-12.7	Look for and make use of structure.

Target 3.2.4 - Real World Applications

- SWBAT write and apply exponential functions to describe and interpret real-world situations. (DOK: 3 - Analysis)

MA.F-LE.A	Construct and compare linear and exponential models and solve problems
MA.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).
MA.F-LE.A.1c	Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.
MA.K-12.1	Make sense of problems and persevere in solving them.
MA.K-12.4	Model with mathematics.
MA.K-12.7	Look for and make use of structure.

Learning Goal 3.3: Brief Review of Units 1 and 2

- SWBAT recall methods of writing and graphing linear and quadratic functions.

MA.F-IF.B.4	For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship.

Target 3.3.1 - Linear Functions

- SWBAT recall methods of writing and graphing linear functions. (DOK: 2 - Comprehension)

MA.F-BF.A.1	Write a function that describes a relationship between two quantities.
MA.F-IF.A.1	Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then $f(x)$ denotes the output of f corresponding to the input x. The graph of f is the graph of the equation $y = f(x)$.
MA.F-IF.B.4	For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship.
MA.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.
MA.F-IF.C.7a	Graph linear and quadratic functions and show intercepts, maxima, and minima.
MA.K-12.1	Make sense of problems and persevere in solving them.
MA.K-12.2	Reason abstractly and quantitatively.
MA.K-12.3	Construct viable arguments and critique the reasoning of others.
MA.K-12.5	Use appropriate tools strategically.
MA.K-12.6	Attend to precision.

Target 3.3.2 - Quadratic Functions

- SWBAT recall methods of writing and graphing quadratic functions. (DOK: 2 - Comprehension)

MA.F-BF.A.1	Write a function that describes a relationship between two quantities.
MA.F-IF.A.1	Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If f is a function and x is an element of its domain, then $f(x)$ denotes the output of f corresponding to the input x. The graph of f is the graph of the equation $y = f(x)$.
MA.F-IF.B.4	For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship.
MA.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.
MA.F-IF.C.7a	Graph linear and quadratic functions and show intercepts, maxima, and minima.
MA.K-12.1	Make sense of problems and persevere in solving them.
MA.K-12.2	Reason abstractly and quantitatively.

MA.K-12.3	Construct viable arguments and critique the reasoning of others.
MA.K-12.5	Use appropriate tools strategically.
MA.K-12.6	Attend to precision.

Learning Goal 3.4: Relating Linear, Quadratic, and Exponential Functions

- SWBAT compare linear, quadratic, and exponential functions.
- SWBAT decide which type of function models specific data sets.

| MA.F-IF.C | Analyze functions using different representations |
| MA.F-IF.C.9 | Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). |

Target 3.4.1 - Comparing Various Functions

- Given an equation, table, or graph of a function, SWBAT distinguish between linear, quadratic, and exponential models. (DOK: 2 - Comprehension)
- SWBAT represent functions in different forms. (For example, express as a graph, an equation of a function given in a table, or based on its verbal description.) (DOK: 2 - Comprehension)

MA.F-IF.C	Analyze functions using different representations
MA.K-12.1	Make sense of problems and persevere in solving them.
MA.K-12.5	Use appropriate tools strategically.

Target 3.4.2 - Writing Various Functions

- SWBAT write linear, quadratic, and exponential functions using tables or graphs. (DOK: 3 - Amalysis)

MA.F-IF.C.9	Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).
MA.K-12.1	Make sense of problems and persevere in solving them.
MA.K-12.2	Reason abstractly and quantitatively.
MA.K-12.5	Use appropriate tools strategically.

Target 3.4.3 - Real-World Applications

- SWBAT apply functions to answering real world questions. (DOK: 4 - Knowledge Utilization)
- SWBAT determine when linear, quadratic, and exponential models can best be used to represent various functions and situations. (DOK: 3 - Analysis)
- SWBAT select the most appropriate representation of a function to use in varied applications. (DOK: 3 - Analysis)
- SWBAT write functions to model varied real world situations. (DOK: 3 - Analysis)

| MA.F-LE.A | Construct and compare linear and exponential models and solve problems |
| MA.F-LE.A.1 | Distinguish between situations that can be modeled with linear functions and with |

exponential functions.

MA.F-LE.B	Interpret expressions for functions in terms of the situation they model
MA.F-LE.B.5	Interpret the parameters in a linear or exponential function in terms of a context.
MA.K-12.1	Make sense of problems and persevere in solving them.
MA.K-12.2	Reason abstractly and quantitatively.
MA.K-12.3	Construct viable arguments and critique the reasoning of others.
MA.K-12.4	Model with mathematics.

Learning Goal 3.5 - Radical Expressions

- SWBAT perform basic operations on radical expressions.

MA.N-RN.A.2	Rewrite expressions involving radicals and rational exponents using the properties of exponents.

Target 3.5.1 - Multiply Radical Expressions

- SWBAT multiply radical expressions. (DOK: 2 - Comprehension)

MA.K-12.6	Attend to precision.
MA.N-RN.A.2	Rewrite expressions involving radicals and rational exponents using the properties of exponents.

Target 3.5.2 - Divide Radical Expressions

- SWBAT simplify fractions containing radical expressions, rationalizing the denominator as needed.
(DOK: 3 - Analysis)

MA.K-12.6	Attend to precision.
MA.K-12.7	Look for and make use of structure.
MA.N-RN.A.2	Rewrite expressions involving radicals and rational exponents using the properties of exponents.

Target 3.5.3 - Add & Subtract Radical Expressions (Level of Difficulty: Comprehension)

- SWBAT add and subtract radical expressions.

MA.K-12.6	Attend to precision.
MA.K-12.7	Look for and make use of structure.
MA.N-RN.A.2	Rewrite expressions involving radicals and rational exponents using the properties of exponents.

Formative Assessment and Performance Opportunities

- Academic Games
- Classroom Discussion
- Classwork
- Closure
- Do Nows
- Group Work
- Homework
- Stations
- Student-Teacher Discussions
- Think-Pair-Share

Summative Assessment

- Performance Task
- Test/Quiz
- Unit Exam

21st Century Life and Careers and Technology

CRP.K-12.CRP2	Apply appropriate academic and technical skills.
CRP.K-12.CRP3	Attend to personal health and financial well-being.
CRP.K-12.CRP4	Communicate clearly and effectively and with reason.
CRP.K-12.CRP6	Demonstrate creativity and innovation.
CRP.K-12.CRP7	Employ valid and reliable research strategies.
CRP.K-12.CRP8	Utilize critical thinking to make sense of problems and persevere in solving them.
CAEP.9.2.12.C.2	Modify Personalized Student Learning Plans to support declared career goals.
CAEP.9.2.12.C.3	Identify transferable career skills and design alternate career plans.
TECH.8.1.12.A.CS2	Select and use applications effectively and productively.
TECH.8.1.12.F.CS3	Collect and analyze data to identify solutions and/or make informed decisions.
TECH.8.2.12.C.2	Analyze a product and how it has changed or might change over time to meet human needs and wants.

Accommodations and Modifications

- 504 Accommodations
- Common Core Workbook Reference 6-1 (Integer Exponents)
- Common Core Workbook Reference 6-2 (Rational Exponents)
- Common Core Workbook Reference 9-2 (Exponential Functions))
- Common Core Workbook Reference 9-3 (Exponential Growth and Decay)

- Common Core Workbook Reference 9-4 (Linear, Quadratic, and Exponential Models)
- IEPs
- Small Group Questions
- Use of Technology - TI-83 graphing calculator

Unit Resources

- Desmos
- Explorations in Core Math for Common Core: Algebra 1 (Holt McDougal)
- Graphing Calculators
- Illustrative Mathematics
- Khan Academy
- Kuta Software
- PARCC/NJSLA Related Questions
- Textbook

Interdisciplinary Connections

Real world applications involving exponential growth and decay can be used to model compound interest when making financial decision (MA.9-12.F-LE.A.1c)

| PFL.9.1.12.C.2 | Compare and compute interest and compound interest and develop an amortization table using business tools. |