Mathematics Curriculum:
Algebra I

MAYWOOD PUBLIC SCHOOLS

JULY, 2012

The following maps outline the Common Core Standards for Algebra I determined by the State Standards Initiative. Below is a list of assessment tools that are recommended for tracking student progress in these areas. In addition, resources that can be used in conjunction with instruction of these standards are provided but not limited to the list below.

Assessment:

Formative Assessment	Class-Work Review
Benchmark Assessment	Math Software (ex. Study Island)
Summative Assessment	Project-Based Assessment
Self-Assessment	Group & Cooperative Work
Teacher Observation	End of Year Assessment
Open-Ended Problems	
Homework Review	

Resources:

Textbooks	Math Journals
Flashcards	Math Songs/Poems
Math Word Wall	Blocks
Rulers	Grid Paper
Number Line	Concrete Objects
Mini White Boards	Protractors
Manipulatives	Three Dimensional Shapes
Calculators (Graphing)	Interactive White Board
Computer Software	

Websites:

http://www.aplusmath.com	www.wolframalpha.com	www.interactmath.com
http://www.studyisland.com	www.kutasoftware.com	www.number2.com
http://www.funbrain.com	www.illuminations.nctm.org	www.khanacademy.org
http://www.songsforteaching.com		www.betterlesson.com
www.purplemath.com		

References: http://www.ade.az.gov/standards/math/2010MathStandards
(+) - Additional mathematics that students should learn in order to take advanced courses such as calculus, advanced statistics, or discrete mathematics in indicated by (+). These standards are included to increase coherence but are not necessarily expected to be addressed on high stakes assessments.

★ - **Standards connected to mathematical modeling.**

Math Curriculum
Algebra I

Essential Question(s): How do students use the notation of mathematics to demonstrate the connections between integer exponents and rational exponents?			
21st Century Theme: Financial, Economic, Business, and Entrepreneurial Literacy			
21st Century Skills: Critical Thinking and Problem Solving, ICT Literacy, Life and Career Skills			
Content: Number and Quantity- *The Real Number System			
Standards: N-RN			
A. Extend the properties of exponents to rational exponents.			
Vocabulary: rational numbers, root, power, exponent, radicals, base, radicand			
Skills	**Instructional Procedures**	**Explanations and Examples**	**Interdisciplinary Connections**
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. *For example, we define $5^{1/3}$ to be the cube root of 5 because we want $(5^{1/3})^3 = 5^{(1/3)3}$ to hold, so $(5^{1/3})^3$ must equal 5.*	• Review properties of exponents to describe rational exponents. • Demonstrate equivalency between radicals and rational exponents. • Evaluate and simplify expressions containing exponents.	Students may explain orally or in written format. $x^a\ (x^b) = x^{(a+b)}$ $y^n = y \bullet y \bullet y \bullet y \bullet \ldots\ldots \bullet y$ Explain why $x^3 \bullet x^2 = x^5$ Explain why $(x^2)^3 = x^6$ Explain why $(x^{-2})^3 = x^{-6}$ The aquarium has the shape of a cube. Each edge is 2.5 feet long a. Find the volume in cubic feet b. How many gallons of water will the aquarium hold? Convert to liquid volume where one cubic foot holds 7.48 gallons. a. $v=s^3$ $=2.5^3$ $=15.625$ ft.^{3} b. $v=15.625$ ft.^{3} $=15.625 \bullet 7.48$ gal $=116.875$ gal	Create a chart of geometric functions used in everyday life.

2. Rewrite expressions involving radicals and rational exponents using the properties of exponents.	• Demonstrate equivalency between rational exponents and radicals.	Examples: • $\sqrt[3]{5^2} = 5^{\frac{2}{3}}$; $5^{\frac{2}{3}} = \sqrt[3]{5^2}$ • Rewrite the expression using fractional exponents: $$\sqrt[5]{16} = \sqrt[5]{2^4} = 2^{\frac{4}{5}}$$ • Rewrite a radical expression in at least three alternate forms. $$x^{-\frac{3}{2}} = \frac{1}{x^{\frac{3}{2}}} = \frac{1}{\sqrt{x^3}} = \frac{1}{x\sqrt{x}}$$ • Rewrite a radical expression using only rational exponents. $\sqrt[4]{2^{-4}} =$	

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Algebra I

Essential Question(s): How do students use the property of closure to determine why sums or products would be rational or irrational?			
21st Century Theme: Financial, Economic, Business, and Entrepreneurial Literacy			
21st Century Skills: Critical Thinking and Problem Solving			
Content: Number and Quantity- *The Real Number System			
Standards: N-RN			
B. Use properties of rational and irrational numbers.			
Vocabulary: nonzero, sum, product, rational, irrational, quotient, difference			
Skills	**Instructional Procedures**	**Explanations and Examples**	**Interdisciplinary Connections**
3. Explain why the sum or product of two rational numbers is rational; that the sum of a rational number and an irrational number is irrational; and that the product of a nonzero rational number and an irrational number is irrational.	• Define rational and irrational numbers. • Provide examples using the closure property starting with integers and expanding to irrational numbers.	Every difference is a sum and every quotient is a product. Review students' understanding of fractions and negative numbers. Explain why the sum of a rational and an irrational number is irrational. Explain why the product of a rational and an irrational number is irrational. Use examples from the four operations to support your answer. Example: Given that π is irrational explain why the number 2π must also be irrational. 2 • (22/7)= 6.28… which is irrational.	

Math Curriculum
Algebra I

Essential Question(s): How can units and conversions play a role in correctness and accuracy of solutions?

21st Century Theme: Financial, Economic, Business, and Entrepreneurial Literacy

21st Century Skills: Critical Thinking and Problem Solving

Content: Number and Quantity- *Qualities

Standards: N-Q

A. Reason quantitatively and use units to solve problems

Vocabulary: margin of error, conversion, reasonable, precision, accuracy

Skills	**Instructional Procedures**	**Explanations and Examples**	**Interdisciplinary Connections**
1. Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.	• Review basic conversions. • Use manipulatives (yard stick, 12 inch ruler, clocks) to visually show the conversion. • Begin with common error problems to emphasize accuracy and detail. • Model conversions and present application problems.	Include word problems where quantities are given in different units, which must be converted to make sense of the problem. For example: An object is moving 12 feet per second and another object is moving at 5 miles per hour. Compare speeds in units. $24000 \text{ sec} \bullet \frac{1\text{min}}{60\text{sec}} \bullet \frac{1\text{hr}}{60\text{min}} \bullet \frac{1\text{day}}{24\text{hr}}$ which is more than 8 miles per hour. Demonstrate graphical representations and data displays such as: line graphs, circle graphs, histograms, multi-line graphs, scatterplots, and multi-bar graphs.	Science conversions
2. Define appropriate quantities for the purpose of descriptive modeling.	• Allow students to examine appropriate models for a number of situations. In small groups, students should create their own example displaying reasonable quantity. • Have students work with actual data and chose the most appropriate model.	Examples: • What type of measurements could be used to determine income and expenses for one month? • Given data about auto accidents in New Jersey, students select an appropriate model to explain the data.	Economics

3. Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.	• Given everyday situations students will select the appropriate measurement tools.	Provide Recipes How would you adjust the amount of each ingredient to produce various quantities? Example: The original recipe serves 8. List the quantity of each ingredient to serve 2, then to serve 12.	

Math Curriculum
Algebra I

Essential Question(s): How does the order of operations apply to varying degrees of expressions and equations?			
21st Century Theme: Financial, Economic, Business, and Entrepreneurial Literacy			
21st Century Skills: Critical Thinking and Problem Solving			
Content: Algebra- *Seeing structure in expressions.			
Standards: A-SSE			
A. Interpret the structure of expressions.			
Vocabulary: coefficient, variable, constant, factors, polynomial, trinomial, binomial, terms, expression, multiples, greatest common factor, quadratic expressions, linear terms			
Skills	**Instructional Procedures**	**Explanations and Examples**	**Interdisciplinary Connections**
1. Interpret expressions that represent a quantity in terms of its context.★ a. Interpret parts of an expression, such as terms, factors, and coefficients. b. Interpret complicated expressions by viewing one or more of their parts as a single entity. *For example, interpret* $P(1+r)^n$ *as the product of P and a factor not depending on P.*	• Identify the parts of a given expression with increasing complexity. • Extend basic properties of arithmetic expressions to algebraic expressions.	Students should be able to identify the parts of an expression. Example: 3x + 5x Identify coefficient of each term. 3(x-2) + 5 (x-2) Identify each term. 3f(x) + 5f(x) Simplify and identify each factor. x(x-2) + 5(x-2) Simplify and identify each term of the quadratic expression.	
2. Use the structure of an expression to identify ways to rewrite it. *For example, see* $x^4 - y^4$ *as* $(x^2)^2 - (y^2)^2$*, thus recognizing it as a difference of squares that can be factored as* $(x^2 - y^2)(x^2 + y^2)$.	• Find the GCF of expressions of increasing complexity, including exponents. • Factor quadratic expressions • Introduce types of factoring	Students should extract the greatest common factor (whether a constant, a variable, or a combination of each). If the remaining expression is quadratic, students should factor the expression further. Example: Factor 4x+16y+32 = 4(x+4y+8) Factor $x^3 - 2x^2 - 35x$ = $x(x^2-2x-35)$ = x(x-7)(x+5)	

Math Curriculum
Algebra I

Essential Question(s): How does the order of operations apply to varying degrees of expressions and equations?			
21st Century Theme: Financial, Economic, Business, and Entrepreneurial Literacy			
21st Century Skills: Critical Thinking and Problem Solving			
Content: Algebra- *Seeing Structure in Expressions.			
Standards: A-SSE			
B. Write expressions in equivalent forms to solve problems.			
Vocabulary: maximum, minimum, factoring, function, exponents			
Skills	**Instructional Procedures**	**Explanations and Examples**	**Interdisciplinary Connections**
3. Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.★ a. Factor a quadratic expression to reveal the zeros of the function it defines. b. Complete the square in a quadratic expression to reveal the maximum or minimum value of the function it defines. c. Use the properties of exponents to transform expressions for exponential functions. *For example the expression* 1.15^t *can be rewritten as*	• Review factoring techniques • Solve quadratic expressions by factoring • Explain standard form of quadratic formula • Model completing the square • Simplify expressions using the properties of exponents	Students will use the properties of operations to create equivalent expressions. Examples: • $5x^2+x=10$ Convert to standard form. • Express $2(x^3 – 3x^2 + x – 6) – (x – 3)(x + 4)$ in factored form and solve for zero. • Simplify an expression. Determine whether the expression gets larger or smaller as *x* increases. ○ $\frac{(2x^3)^2(3x^4)}{(x^2)^3}$	<u>Economics:</u> Interest rate amortization <u>Science:</u> Half Life

$(1.15^{1/12})^{12t} \approx 1.012^{12t}$ to reveal the approximate equivalent monthly interest rate if the annual rate is 15%.			

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Essential Question(s): How can we perform operations with polynomials to solve problems?			
21st Century Theme: Financial, Economic, Business, and Entrepreneurial Literacy			
21st Century Skills: Critical Thinking and Problem Solving			
Content: Algebra- *Arithmetic with Polynomials and Rational Expressions			
Standards: A.APR			
A. Write expressions in equivalent forms to solve problems.			
Vocabulary: Polynomial, binomial, trinomial, monomial, degree of a polynomial, leading coefficient, constant, linear, quadratic, cubic			
Skills	**Instructional Procedures**	**Explanations and Examples**	**Interdisciplinary Connections**
1. Understand that polynomials form a system analogous to the integers, namely, they are closed under the operations of addition, subtraction, and multiplication; add, subtract, and multiply polynomials.	• Demonstrate ways to write equivalent forms of expressions ○ Add ○ Subtract ○ Multiply	$(2x^2+x-5) + (x+x^2+6) = (2x^2+x^2) + (x+x) + (-5+6)$ ← Addition $=3x^2+2x+1$ $(x^2-8) - (7x+4x^2)$ $x^2 \quad -8$ ← Subtraction $\underline{-4x^2 \quad -7x}$ $-3x^2 \quad -7x \quad -8$ $10x(14x-2) = 140x^2-20x$ ← Multiplication	

Math Curriculum
Algebra I

Essential Question(s): How can we create appropriate equations and models to describe situations?

21st Century Theme: Financial, Economic, Business, and Entrepreneurial Literacy

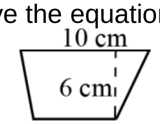
21st Century Skills: Critical Thinking and Problem Solving

Content: Algebra- *Creating Equations

Standards: A.CED

A. Create equations that describe numbers or relationships.

Vocabulary: matrices, coordinate plane, equation, inequality, greater than, less than, more than, at least, systems of equations

Skills	**Instructional Procedures**	**Explanations and Examples**	**Interdisciplinary Connections**
1. Create equations and inequalities in one variable and use them to solve problems. *Include equations arising from linear and quadratic functions, and simple rational and exponential functions.*	• Provide models of linear and quadratic functions. Use simple, rational and exponential functions in word problems. • Provide models of inequalities.	Equations can represent real world and mathematical problems. Include equations and inequalities that arise when comparing the values of two different functions, such as one describing linear growth and one describing exponential growth. Examples: • Given that the following trapezoid has area 54 cm^2, set up an equation to find the length of the base, and solve the equation.  • Lava coming from the eruption of a volcano follows a parabolic path. The height *h* in feet of a piece of lava *t* seconds after it is ejected from the volcano is given by $h(t) = -t^2 + 16t + 936$. When does the lava reach its maximum height of 1000 feet?	Chemistry Physics Biology
2. Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.	• Review techniques for solving systems of equations: ○ Substitution ○ Multiplication ○ Addition/ subtraction ○ Graphing ○ Matrices • Review graphing	Students will solve a system of equations using substitution, multiplication, addition/subtraction or graphing methods. This can be extended to include matrices. x+9y=42 6x-y=16	

3. Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context. *For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.*	• Solve equations/ inequalities • Test reasonableness of solutions	Example: • A club is selling hats and jackets as a fundraiser. Their budget is \$1500 and they want to order at least 250 items. They must buy at least as many hats as they buy jackets. Each hat costs \$5 and each jacket costs \$8. ○ Write a system of inequalities to represent the situation. ○ Graph the inequalities. ○ If the club buys 150 hats and 100 jackets, will the conditions be satisfied? ○ What is the maximum number of jackets they can buy and still meet the conditions?	
4. Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. *For example, rearrange Ohm's law V = IR to highlight resistance R.*	• Isolate the selected variable to solve an equation.	Examples: • The Pythagorean Theorem expresses the relation between the legs a and b of a right triangle and its hypotenuse c with the equation $a^2 + b^2 = c^2$. • Why might the theorem need to be solved for c? • Solve the equation for c and write a problem situation where this form of the equation might be useful. • Solve $V = \frac{4}{3}\pi r^3$ for radius ***r.*** • Motion can be described by the formula below, where *t* = time elapsed, *u*=initial velocity, *a* = acceleration, and *s* = distance traveled $s = ut + \frac{1}{2}at^2$ ○ Why might the equation need to be rewritten in terms of *a*? ○ Rewrite the equation in terms of *a*.	Science Formulas

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Essential Question(s): What strategies are most efficient in solving equations and inequalities?			
21st Century Theme: Financial, Economic, Business, and Entrepreneurial Literacy			
21st Century Skills: Critical Thinking and Problem Solving, ICT Literacy			
Content: Algebra- *Reasoning with Equations and Inequalities			
Standards: A.REI			
A. **Understand solving equations as a process of reasoning and explain the reasoning.**			
Vocabulary: equality, inequality, solution, variable, unknown			
Skills	**Instructional Procedures**	**Explanations and Examples**	**Interdisciplinary Connections**
1. Explain each step in solving a simple equation as following from the equality of numbers asserted at the previous step, starting from the assumption that the original equation has a solution. Construct a viable argument to justify a solution method.	• Review properties of equality and explain how they are used to solve simple equations • Review order of operations and extend to solving multi-step equations	Properties of operations can be used to simplify expressions on either side of the equation. Adding the same term to both sides of an equation or multiplying both sides by a non-zero constant produces an equivalent equation. Examples: • Explain why the equation $x/2 + 7/3 = 5$ has the same solution as the equation $3x + 14 = 30$. Does this mean that $x/2 + 7/3$ is equal to $3x + 14$? • Show that $x = 2$ and $x = -3$ are solutions to the equation $x^2 + x = 6$.	Career and Life Skills

Essential Question(s): How can we determine which method is best to solve a problem?

21st Century Theme: Financial, Economic, Business, and Entrepreneurial Literacy

21st Century Skills: Critical Thinking and Problem Solving

Content: Algebra- *Reasoning with Equations and Inequalities

Standards: A.REI

B. Solve equations and inequalities in one variable.

Vocabulary: equality, inequality, literal, quadratic, number lines, real number, complex numbers, discriminate, root

<table>
<tr><th>Skills</th><th>Instructional Procedures</th><th>Explanations and Examples</th><th>Interdisciplinary Connections</th></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>3. Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.</td><td>• Compare linear equations to linear inequalities and their graphic representations
• Compare 3x+7=12 to ax+7=12</td><td>Examples:
• $-\frac{7}{3}y-8=111$
• $3x > 9$, $3x = 9$ Graph and compare results
• $\frac{3+x}{7}=\frac{x-9}{4}$, $\frac{3+x}{7}<\frac{x-9}{4}$ Graph and compare results

Solve for x: $2/3x + 9 < 18$</td><td>Career and Life Skills
Use curfew hours
Use work hours.
Use driving age/insurance rates.</td></tr>
<tr><td>4. Solve quadratic equations in one variable.

a. Use the method of completing the square to transform any quadratic equation in x into an equation of the form $(x - p)^2 = q$ that has the same solutions. Derive the quadratic formula from this form.

b. Solve quadratic equations by inspection (e.g., for $x^2 = 49$), taking square roots, completing the square, the quadratic</td><td>• Discuss the difference between an expression and an equation
• Explain and define the zero product property
• Use factoring techniques to solve quadratic equations
• Use completing the square method to solve quadratic equations
• Derive the quadratic formula from $ax^2 +bx+c=0$
• Determine the zeros of the function
• Compare and contrast the usefulness of each method of solving quadratics equations</td><td>Students should solve by factoring, completing the square, and using the quadratic formula. The zero product property is used to explain why the factors are set equal to zero. Students should relate the value of the discriminant to the type of root to expect. A natural extension would be to relate the type of solutions to the standard form of the quadratic equation to the behavior of the function of y.

<table><tr><th>Value of Discriminant</th><th>Nature of Roots</th><th>Nature of Graph</th></tr><tr><td>$b^2 - 4ac = 0$</td><td>1 real roots</td><td>intersects x-axis once</td></tr><tr><td>$b^2 - 4ac > 0$</td><td>2 real roots</td><td>intersects x-axis twice</td></tr><tr><td>$b^2 - 4ac < 0$</td><td>2 complex roots</td><td>does not intersect x-axis</td></tr></table>
• Are the roots of $2x^2 + 5 = 2x$ real or complex? How many roots does it have? Find all solutions of the equation.

What are the roots of $x^2 + 6x + 10 = 0$? Solve the equation using the quadratic formula and completing the square.
How are the two methods related?</td><td></td></tr>
</table>

formula and factoring, as appropriate to the initial form of the equation. Recognize when the quadratic formula gives complex solutions and write them as $a \pm bi$ for real numbers a and b.			

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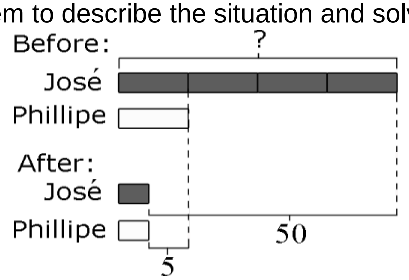
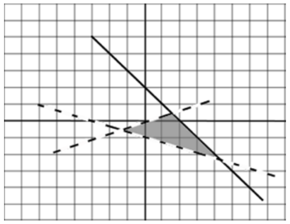
Essential Question(s): How can we apply mathematics to solve real world problems involving two entities?			
21st Century Theme: Financial, Economic, Business, and Entrepreneurial Literacy			
21st Century Skills: Critical Thinking and Problem Solving			
Content: Algebra- *Reasoning with Equations and Inequalities			
Standards: A.REI			
C. Solve systems of equations.			
Vocabulary: System of equations, substitution method, elimination method, graphic method, intersecting lines, parallel lines, coinciding lines			
Skills	**Instructional Procedures**	**Explanations and Examples**	**Interdisciplinary Connections**
5. Prove that, given a system of two equations in two variables, replacing one equation by the sum of that equation and a multiple of the other produces a system with the same solutions.	• Review solving equations for a specified value and simplifying expressions. • Review elimination method of solving systems of linear equations.	Stress that the property of equality extends to adding equivalent expressions to each side of an equation. Example: Given that the sum of two numbers is 10 and their difference is 4, what are the numbers? Explain how your answer can be deduced from the fact that two numbers, x and y, satisfy the equations $x + y = 10$ and $x – y = 4$.	Technology- spreadsheets
6. Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.	• Review graphing equations • Convert the solution of the system to its graphical representation • Use substitution property of equality to solve system of equations. • Compare and contrast various methods of solving systems of linear equations.	The system solution methods can include but are not limited to graphical, elimination/linear combination, substitution, and modeling. Systems can be written algebraically or can be represented in context. Students may use graphing calculators, programs, or applets to model and find approximate solutions for systems of equations. Examples: • José had 4 times as many trading cards as Phillipe. After José gave away 50 cards to his little brother and Phillipe gave 5 cards to his friend for this birthday, they each had an equal amount of cards. Write a system to describe the situation and solve the system.  	

		• Solve the system of equations: $x + y = 11$ and $3x - y = 5$. Use a second method to check your answer. The opera theater contains 1,200 seats, with three different prices. The seats cost $45 dollars per seat, $50 per seat, and $60 per seat. The opera needs to gross $63,750 on seat sales. There are twice as many $60 seats as $45 seats. How many seats in each level need to be sold?	
7. Solve a simple system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. For example, find the points of intersection between the line $y = -3x$ and the circle $x^2 + y^2 = 3$.	• Review graphing linear and quadratic equations • Discuss the meaning of their points of intersection • Discuss algebraic method for solving a linear-quadratic system	Example: Find the points of intersection between the line $y = -3x$ and the circle $x^2 + y^2 = 3$.	

Essential Question(s): How can we use mathematics to visually represent the solutions to problems?			
21st Century Theme: Financial, Economic, Business, and Entrepreneurial Literacy, Global Awareness			
21st Century Skills: Critical Thinking and Problem Solving			
Content: Algebra- *Reasoning with Equations and Inequalities			
Standards: A.REI			
C. Represent and solve equations and inequalities graphically.			
Vocabulary: solutions, non-solutions, relations, functions, functional notation, half-plane, boundary			
Skills	**Instructional Procedures**	**Explanations and Examples**	**Interdisciplinary Connections**
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).	• Use an equation to construct a table of values, graph the points, compare and discuss solutions and non-solutions	Example: • Which of the following points is on the circle with equation $(x-1)^2+(y+2)^2=5$? (a) (1, -2) (b) (2, 2) (c) (3, -1) (d) (3, 4)	
11. Explain why the *x*-coordinates of the points where the graphs of the equations *y* = *f*(*x*) and *y* = *g*(*x*) intersect are the solutions of the equation *f*(*x*) = *g*(*x*); find the solutions approximately, e.g., using technology to graph the functions, make tables of values, or find successive approximations. Include cases where *f*(*x*) and/or *g*(*x*) are linear, polynomial, rational, absolute value, exponential, and logarithmic functions.★	• Use technology to graph functions and examine tables • Review functional notation • Relate the algebraic solution to the graph of the function	Students may use graphing calculators or programs to generate tables of values, graph, or solve a variety of functions. Students need to understand that numerical solution methods (data in a table used to approximate an algebraic function) and graphical solution methods may produce approximate solutions, and algebraic solution methods produce precise solutions that can be represented graphically or numerically. Example: • Given the following equations determine the *x* value that results in an equal output for both functions. $f(x)=3x-2$ $g(x)=(x+3)^2-1$	

12. Graph the solutions to a linear inequality in two variables as a half-plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes.	• Compare the graphs of the solution of the following y = 2x+3 y ≤ 2x+3 y < 2x+3 • Graph systems of linear equalities and describe the meaning of the solution set. ○ What does it mean to be an element of the solution set? ○ What does it mean to not be an element of the solution set? • Use technology to help determine solutions.	Students may use graphing calculators, programs, or applets to model and find solutions for inequalities or systems of inequalities. Examples: • Graph the solution: y = 2x+3, *y* ≤ 2*x* + 3, y < 2x+3 • A publishing company publishes a total of no more than 100 magazines every year. At least 30 of these are women's magazines, but the company always publishes at least as many women's magazines as men's magazines. Find a system of inequalities that describes the possible number of men's and women's magazines that the company can produce each year consistent with these policies. Graph the solution set. • Graph the system of linear inequalities below and determine if (3, 2) is a solution to the system. $\begin{cases} x-3y>0 \\ x+y\le 2 \\ x+3y>-3 \end{cases}$ Solution:  (3, 2) is not an element of the solution set (graphically or by substitution).	

Math Curriculum
Algebra I

Essential Question(s): How do functions give us insight into the nature of relationships?

21st Century Theme: Financial, Economic, Business, and Entrepreneurial Literacy

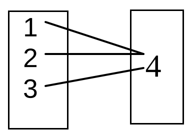
21st Century Skills: Critical Thinking and Problem Solving

Content: Functions- *Interpreting Functions

Standards: F.IF

A. Understand the concept of a function and use function notation

Vocabulary: function, domain, range, input, output, function notation, mapping diagram, vertical line test, set, ordered pairs, recursive, sequence

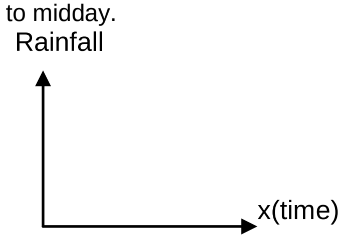
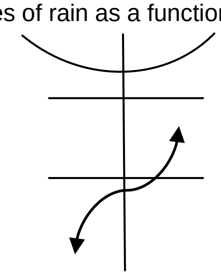
Skills	**Instructional Procedures**	**Explanations and Examples**	**Interdisciplinary Connections**
1. Understand that a function from one set (called the domain) to another set (called the range) assigns to each element of the domain exactly one element of the range. If *f* is a function and *x* is 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*).	• Use real relationships to demonstrate functions and relations. • Have students come up with own examples. • Translate to creating mapping diagram with numbers • Graph ordered pairs, compare function vs. non-function to determine graphical appropriate- vertical line test	The domain of a function given by an algebraic expression, unless otherwise specified, is the largest possible domain. Domain Range Players → teams List players ↗ List Teams → Students give examples of non-functions. Identify lists of ordered pairs that are function and non-function. {(0,1), (0,2), (1,4)} NOT  Use graphing software (ex. Geogebra) to display y=x+2 and f(x)=x+2.	Life and career skills: Have students construct examples of "good" vs. "bad" relationships with both real world relationships and number relationships.
2. Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.	• Analyze a graph to determine domain and input of function notation	The domain of a function given by an algebraic expression, unless otherwise specified, is the largest possible domain. Have student solve and demonstrate with graph calculator. Examples: Demonstrate with graph calculator. • If $f(x)=x^2+4x-12$, find $f(2)$. --(f(2) if y when x+2 • Let $f(x)=2(x+3)^2$. Find $f(3)$, $f(-\frac{1}{2})$, $f(a)$, and $f(a-h)$	

		If P(*t*) is the population of Tucson *t* years after 2000, interpret the statements P(0) = 487,000 and P(10)-P(9) = 5,900 P(1) Explain the result of P(10)-P(9)	
3. Recognize that sequences are functions, sometimes defined recursively, whose domain is a subset of the integers. *For example, the Fibonacci sequence is defined recursively by f(0) = f(1) = 1, f(n+1) = f(n) + f(n-1) for n ≥ 1.*	• Review various linear/non-linear sequences • Determine patterns not in a function • Review Fibonacci Sequence of rectangular numbers	Example: If x is: 2, 5, 8, 11, … f(x)=3x-1 x | y The rate of change is 3. 1 | 2 } 3 2 | 5 } 3 | 8 } 3 4 | 11 } 3	<u>Art:</u> Golden Ratio Graphic Design <u>Aesthetics:</u> Architectures

Math Curriculum
Algebra I

Essential Question(s): How do different representations of functions allow for different interpretations or applications of a function?
21st Century Theme: Financial, Economic, Business, and Entrepreneurial Literacy
21st Century Skills: Critical Thinking and Problem Solving
Content: Functions- *Interpreting Functions
Standards: F.IF
C. Analyze functions using different representations.
Vocabulary: interval, increasing, decreasing, maxima/ minimum, end behavior/ periodicity, intercepts

Skills	**Instructional Procedures**	**Explanations and Examples**	**Interdisciplinary Connections**

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. *Key features include: intercepts; intervals where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; and periodicity*.★	• Review graphing linear and non linear functions
	• Determine domain and range
	• Analyze the graph
	• Sketch graphs to show key features
	• Determine domain and range of a given graph
		Students will use data to interpret or produce graphs for a given expression.
		
		Examples:
		• A rocket is launched from 180 feet above the ground at time $t = 0$. The function that models this situation is given by $h = -16t^2 + 96t + 180$, where t is measured in seconds and h is height above the ground measured in feet.
		  ○ What is a reasonable domain restriction for t in this context?
		  ○ Determine the height of the rocket two seconds after it was launched.
		  ○ Determine the maximum height obtained by the rocket.
		  ○ Determine the time when the rocket is 100 feet above the ground.
		  ○ Determine the time at which the rocket hits the ground.
		  ○ How would you refine your answer to the first question based on your response to the second and fifth questions?
		• Compare the graphs of $y = 3x^2$ and $y = 3x^3$.
		• Let $R(x) = \frac{2}{\sqrt{x-2}}$. Find the domain, range, zeros, and asymptotes of $R(x)$.
		• Let $f(x) = 5x^3 - x^2 - 5x + 1$. Graph the function and identify end behavior and any intervals of constancy, increase, and decrease.
		
		• It started raining lightly at 5am, then the rainfall became heavier at 7am. By 10am the storm was over, with a total rainfall of 3 inches. It didn't rain for the rest of the day. Sketch a graph for the number of inches of rain as a function of time, from midnight to midday.
		
		
			Physics
			Civic Literacy
			Brussels/ Space Travel

<table>
<tr>
<td>5. Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.★</td>
<td>• Discuss the appropriate units of domain and range given real life situations.</td>
<td>Students will explain the existing relationships between domain and range.
For example, if the function h(n) gives the number of person-hours it takes to assemble n engines in a factory, then the positive integers would be an appropriate domain for the function.
Match reasonable domain and range for student generated problems.</td>
<td></td>
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<tr>
<td>6. Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.★</td>
<td>Use slope formula to show how x any y values describe the growth/decay of the function.
Compare tables that show consistent rate of change (linear) and others that do not.</td>
<td>The average rate of change of a function y = f(x) over an interval [a,b] is
$\frac{\Delta y}{\Delta x} = \frac{f(b)-f(a)}{b-a}$
Determine the average rates of change for functions given symbolically, graphically, or in a table.
Students will collect data from experiments or simulations (ex. falling ball, velocity of a car, etc.) and determine average rates of change for the function modeling the situation.

Examples:
Use the following table determine the average rate of change of g over the intervals [-2, -1] and [0,2]:<table><tr><th>x</th><th>g(x)</th></tr><tr><td>-2</td><td>2</td></tr><tr><td>-1</td><td>-1</td></tr><tr><td>0</td><td>-4</td></tr><tr><td>2</td><td>-10</td></tr></table>
The table below shows the elapsed time when two different cars pass a 10, 20, 30, 40 and 50 meter mark on a test track.
For car 1, what is the average velocity (change in distance divided by change in time) between the 0 and 10 meter mark? Between the 0 and 50 meter mark? Between the 20 and 30 meter mark? Analyze the data to describe the motion of car 1.
How does the velocity of car 1 compare to that of car 2?
<table><tr><th></th><th>Car 1</th><th>Car 2</th></tr><tr><th>d</th><th>t</th><th>t</th></tr><tr><td>10</td><td>4.472</td><td>1.742</td></tr><tr><td>20</td><td>6.325</td><td>2.899</td></tr><tr><td>30</td><td>7.746</td><td>3.831</td></tr><tr><td>40</td><td>8.944</td><td>4.633</td></tr><tr><td>50</td><td>10</td><td>5.348</td></tr></table></td>
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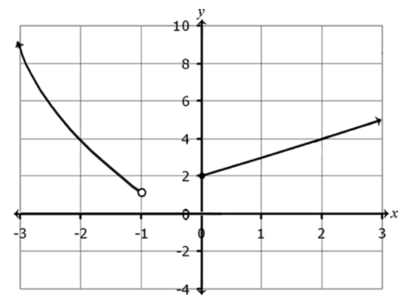
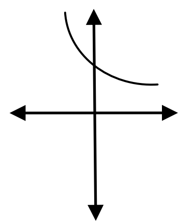
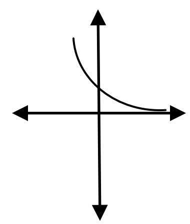
</table>

Math Curriculum
Algebra I

Essential Question(s): How do different representations of functions allow for different interpretations or applications of a function?			
21st Century Theme: Financial, Economic, Business, and Entrepreneurial Literacy			
21st Century Skills: Critical Thinking and Problem Solving			
Content: Functions- *Interpreting Functions			
Standards: F.IF			
C. Analyze functions using different representations.			
Vocabulary: intercepts, maxima, minima, translation, asymptote, piecewise, polynomials, zeros, roots, growth, decay			
Skills	**Instructional Procedures**	**Explanations and Examples**	**Interdisciplinary Connections**
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 linear and quadratic functions and show intercepts, maxima, and minima. b. Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions. c. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.	• Use software to demonstrate different types of function. • Use graphs to introduce terminology (intercepts, maxima and minima) • Use parabolas to identify when a quadratic can be factored into binomials. • Use technology to identify the key characteristics of the function	Key characteristics include: maxima, minima, intercepts, symmetry, end behavior, and asymptotes. Students may use technology to graph functions. Examples: • Describe key characteristics of the graph of $f(x) = \lvert x - 3 \rvert + 5$. • Sketch the graph and identify the key characteristics of the function described below. $F(x) = \begin{cases} x+2 \text{ for } x \geq 0 \\ -x^2 \text{ for } x < -1 \end{cases}$  • Graph the function $f(x) = 2^x$ by creating a table of values. Identify the key characteristics of the graph. • Graph $f(x) = 2 \tan x - 1$. Describe its domain, range, intercepts, and asymptotes. • Draw the graph of $f(x) = \sin x$ and $f(x) = \cos x$. What are the similarities and differences between the two graphs?	

d. (+) Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior. e. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.			
8. Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. a. Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context. b. Use the properties of exponents to interpret expressions for exponential functions. For example, identify percent rate of change in functions such as y = (1.02)t, y = (0.97)t, y = (1.01)12t, y = (1.2)t/10, and classify them as representing exponential growth or decay.	• Show graphs of growth and decay and use Computer Assisted Software to match equations • Determine which equations result in growth or decay • Given an equation describe the attributes of a graph	Example  $y=(1/2)^x$  $y= (.075)^x$ Students conclude that decay means constant is <1.	

9. Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). *For example, given a graph of one quadratic function and an algebraic expression for another, say which has the larger maximum.*	• Discuss translations and transformations • Discuss properties of functions	Example: • Examine the functions below. Which function has the larger maximum? How do you know? $f(x) = -2x^2 - 8x + 20$ $f(x) = -x^2 + 3x - 11$	

Math Curriculum
Algebra I

Essential Question(s): How can we model relationships using mathematics?			
21st Century Theme: Financial, Economic, Business, and Entrepreneurial Literacy			
21st Century Skills: Critical Thinking and Problem Solving			
Content: Functions- *Building Functions			
Standards: F.BF			
A. Build a function that models a relationship between two quantities.			
Vocabulary: relationship, recursive, geometric, exponential, model			
Skills	**Instructional Procedures**	**Explanations and Examples**	**Interdisciplinary Connections**
1. Write a function that describes a relationship between two quantities.★ a. Determine an explicit expression, a recursive process, or steps for calculation from a context. b. Combine standard function types using arithmetic operations. *For example, build a function that models the temperature of a cooling body by adding a constant function to a decaying exponential, and relate these functions to the model.*	• Given a table of values students will determine function rules and relationships • Given open ended questions students will determine function rules and relationships	• Students will analyze a given problem to determine the function expressed by identifying patterns in the function's rate of change. • Students will specify intervals of increase, decrease, constancy, and relate the function's description in words. • Students will use computer assisted technology to model various functions.	

2. Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.★	• Students will write arithmetic and geometric sequences recursively • Students will use sequences to model real life situations	An explicit rule for the *n*th term of a sequence gives a_n as an expression in the term's position *n*; a recursive rule gives the first term of a sequence, and a recursive equation relates a_n to the preceding term(s). Both methods of presenting a sequence describe a_n as a function of *n*. Examples: • Generate the 5th-11th terms of a sequence if A_1= 2 and $A_{(n+1)} = (A_n)^2 - 1$ • Use the formula: $A_n = A_1 + d(n - 1)$ where d is the common difference to generate a sequence whose first three terms are: -7, -4, and -1. • There are 2,500 fish in a pond. Each year the population decreases by 25 percent, but 1,000 fish are added to the pond at the end of the year. Find the population in five years. Also, find the long-term population. • Given the formula $A_n = 2n - 1$, find the 17th term of the sequence. What is the 9th term in the sequence 3, 5, 7, 9, …? • Given $a_{(1)} = 4$ and $a_{(n)} = a_{(n-1)} + 3$, write the explicit formula.	Golden Ratio Fibonacci Sequence Appearance of sequences and series in nature

Math Curriculum
Algebra I

Essential Question(s): How does the relationship between a parent function and translations of it help us to understand how to build functions?

21st Century Theme: Financial, Economic, Business, and Entrepreneurial Literacy

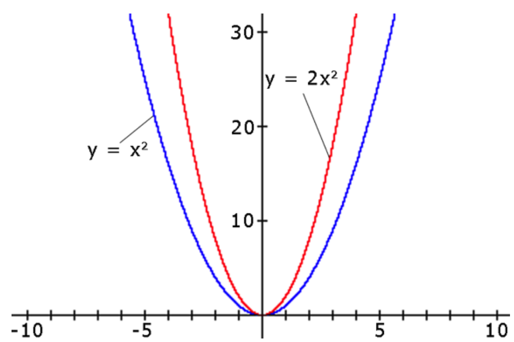
21st Century Skills: Critical Thinking and Problem Solving

Content: Functions- *Building Functions

Standards: F.BF

B. Build new functions from existing functions.

Vocabulary: parent function, vertical and horizontal translation, inverse function

Skills	**Instructional Procedures**	**Explanations and Examples**	**Interdisciplinary Connections**
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. Include recognizing even and odd functions from their graphs and algebraic expressions for them.	• Determine the effect a constant has in various positions of the parent function	Students will apply transformations to functions and recognize functions as even and odd. Students may use computer assisted software. Examples: • Is $f(x) = x^3 - 3x^2 + 2x + 1$ even, odd, or neither? Explain your answer orally or in written format.. • Compare the shape and position of the graphs of $f(x) = x^2$ and $g(x) = 2x^2$, and explain the differences in terms of the algebraic expressions for the functions  • Describe effect of varying the parameters *a*, *h*, and *k* have on the shape and position of the graph of $f(x) = a(x-h)^2 + k$.	

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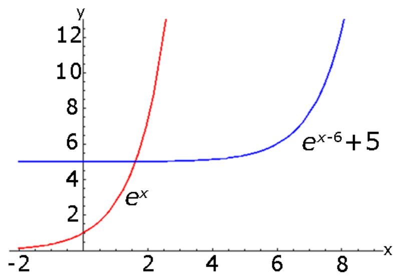
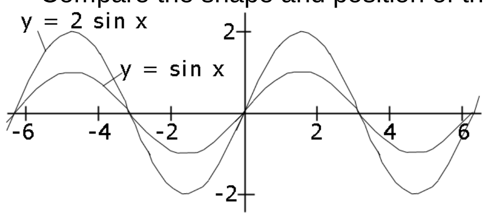
- Compare the shape and position of the graphs of $f(x) = e^x$ to $g(x) = e^{x-6} + 5$, and explain the differences, orally or in written format, in terms of the algebraic expressions for the functions



- Describe the effect of varying the parameters *a, h,* and *k* on the shape and position of the graph f(*x*) = $ab^{(x+h)}$ + k., orally or in written format. What effect do values between 0 and 1 have? What effect do negative values have?

- Compare the shape and position of the graphs of *y* = sin *x* to *y* = 2 sin *x.*



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4. Find inverse functions.

a. Solve an equation of the form f(x) = c for a simple function f that has an inverse and write an expression for the inverse. *For example, f(x) =2 x^3 or f(x) = (x+1)/(x–1) for x ≠ 1.*

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- Explain the results of switching an x and y value in an ordered pair
- Graph sets of coordinates and their inverses to determine the relationship between a function and its inverse
- Determine an inverse algebraically and graphically

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Students may use computer assisted software to model functions.

Examples:

- For the function *h*(*x*) = $(x – 2)^3$, defined on the domain of all real numbers, find the inverse function if it exists or explain why it doesn't exist.
- Graph h(*x*) and $h^{-1}(x)$ and explain how they relate to each other graphically.
- Find a domain for f(*x*) = $3x^2 + 12x - 8$ on which it has an inverse. Explain why it is necessary to restrict the domain of the function.

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Math Curriculum
Algebra I

Essential Question(s): How do functions appear in daily living?			
21st Century Theme: Financial, Economic, Business, and Entrepreneurial Literacy			
21st Century Skills: Critical Thinking and Problem Solving			
Content: Functions- *Linear, Quadratic, and Exponential Models			
Standards: F.L.E.			
B. Build new functions from existing functions.			
Vocabulary: linear function, exponential function, simple interest, compound interest, arithmetic sequence, geometric sequence			
Skills	**Instructional Procedures**	**Explanations and Examples**	**Interdisciplinary Connections**
1. Distinguish between situations that can be modeled with linear functions and with exponential functions. a. Prove that linear functions grow by equal differences over equal intervals, and that exponential functions grow by equal factors over equal intervals. b. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another. c. Recognize situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another.	• Define linear functions and exponential functions Graph y=x Graph $y=2^x$ •Compare linear functions and exponential functions • Calculate simple and compound interest	Students may use computer assisted technology to model and compare linear and exponential functions. Examples: • A cell phone company has three plans. Graph the equation for each plan, and analyze the change as the number of minutes used increases. When is it beneficial to enroll in Plan 1? Plan 2? Plan 3? 1. $59.95/month for 700 minutes and $0.25 for each additional minute, 2. $39.95/month for 400 minutes and $0.15 for each additional minute, and 3. $89.95/month for 1,400 minutes and $0.05 for each additional minute. • A computer store sells about 200 computers at the price of $1,000 per computer. For each $50 increase in price, about ten fewer computers are sold. How much should the computer store charge per computer in order to maximize their profit? Students will investigate functions and graphs modeling different situations involving simple and compound interest. Students will compare interest rates with different periods of compounding (monthly, daily) and compare them with the corresponding annual percentage rate. • A couple wants to buy a house in five years. They need to save a down payment of $8,000. They deposit $1,000 in a bank account earning 3.25% interest, compounded quarterly. How much will they need to save each month in order to meet their goal? • Sketch and analyze the graphs of the following two situations. What information can you conclude about the types of growth each type of interest has? ○ Lee borrows $9,000 from his mother to buy a car. His mom	Business Credit Cards Science Half-Life Double- Life Radioactive decay

<table>
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<td>charges him 5% interest a year, but she does not compound the interest.
Lee borrows $9,000 from a bank to buy a car. The bank charges 5% interest compounded annually.
Calculate the future value of a given amount of money, with and without technology.
Calculate the present value of a certain amount of money for a given length of time in the future, with and without technology.</td>
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<tr>
<td>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).</td>
<td>• Given a graph of a function, identify the characteristics given
• Write an algebraic sequence to describe a real-life situation</td>
<td>Examples:
Determine an exponential function of the form $f(x) = ab^x$ using data points from the table. Graph the function and identify the key characteristics of the graph.
<table><tr><td>x</td><td>f(x)</td></tr><tr><td>0</td><td>1</td></tr><tr><td>1</td><td>3</td></tr><tr><td>3</td><td>27</td></tr></table>
Sara’s starting salary is $32,500. Each year she receives a $700 raise. Write a sequence in explicit form to describe the situation.</td>
<td></td>
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<tr>
<td>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.</td>
<td>• Compare and contrast exponential, linear and polynomial functions.</td>
<td>Example:
Contrast the growth of the $f(x)=x^3$ and $f(x)=3^x$.</td>
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</table>

Math Curriculum
Algebra I

Essential Question(s): How do functions appear in daily living?			
21st Century Theme: Financial, Economic, Business, and Entrepreneurial Literacy			
21st Century Skills: Critical Thinking and Problem Solving			
Content: Functions- *Linear, Quadratic, and Exponential Models			
Standards: F.L.E.			
C. Interpret expressions for functions in terms of the situation they model.			
Vocabulary: linear, quadratic or exponential functions			
Skills	**Instructional Procedures**	**Explanations and Examples**	**Interdisciplinary Connections**
5. Interpret the parameters in a linear or exponential function in terms of a context.	• Model and interpret parameters in linear, quadratic or exponential functions.	Students will use computer assisted technology to model and interpret parameters in linear, quadratic or exponential functions. Example: • A function of the form $f(n) = P(1 + r)^n$ is used to model the amount of money in a savings account that earns 5% interest, compounded annually, where n is the number of years since the initial deposit. What is the value of r? Explain the meaning of the constant P in terms of the savings account?	

Math Curriculum
Algebra I

Essential Question(s): What is the effect of measures of central tendency in interpreting data?

21st Century Theme: Financial, Economic, Business, and Entrepreneurial Literacy

21st Century Skills: Critical Thinking and Problem Solving

Content: Statistics and Probability- *Interpreting Categorical and Quantitative Data

Standards: S.ID

A. Summarize, represent, and interpret data on a single count or measurement variable.

Vocabulary: media, mean, mode, stem and leaf plot, box and whisker plot, histogram, scatter plot (dot plots), standard deviation, inter-quartile range, outlier, range

Skills	**Instructional Procedures**	**Explanations and Examples**	**Interdisciplinary Connections**
1. Represent data with plots on the real number line (dot plots, histograms, and box plots).	• Review properties of the number line (x-axis)	Students will illustrate different kinds of graphs: dot plots, histogram, box and whisker.	
2. Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (inter-quartile range, standard deviation) of two or more different data sets.	• Explain measures of central tendency • Explain/ model standard deviation • Compare/contrast sets of data by choosing appropriate statistics	Students will use computer assisted technology for calculations, summaries, and comparisons of data sets. Examples: • The two data sets below depict the housing prices sold in the King River area and Toby Ranch areas of Pinal County, Arizona. Based on the prices below which price range can be expected for a home purchased in Toby Ranch? In the King River area? In Pinal County? ○ King River area {1.2 million, 242000, 265500, 140000, 281000, 265000, 211000} ○ Toby Ranch homes {5million, 154000, 250000, 250000, 200000, 160000, 190000} • Given a set of test scores: 99, 96, 94, 93, 90, 88, 86, 77, 70, 68, find the mean, median and standard deviation. Explain how the values vary about the mean and median. What information does this give the teacher?	Biology Plant growth Census data
3. Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).	• Compare/contrast multiple sets of data accounting for outliers	Students may use spreadsheets, graphing calculators and statistical software to statistically identify outliers and analyze data sets with and without outliers as appropriate.	Marketing

Math Curriculum
Algebra I

<table>
<tr><td colspan="4">Essential Question(s): What is the effect of measures of central tendency in interpreting data?</td></tr>
<tr><td colspan="4">21st Century Theme: Financial, Economic, Business, and Entrepreneurial Literacy</td></tr>
<tr><td colspan="4">21st Century Skills: Critical Thinking and Problem Solving</td></tr>
<tr><td colspan="4">Content: Statistics and Probability- *Interpreting Categorical and Quantitative Data</td></tr>
<tr><td colspan="4">Standards: S.ID</td></tr>
<tr><td colspan="4">B. Summarize, represent, and interpret data on two categorical and quantitative variables.</td></tr>
<tr><td colspan="4">Vocabulary: joint, marginal and conditional relative frequencies, trends, residual, regression, function, scatter plot</td></tr>
<tr><td>Skills</td><td>Instructional Procedures</td><td>Explanations and Examples</td><td>Interdisciplinary Connections</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>5. Summarize categorical data for two categories in two-way frequency tables. Interpret relative frequencies in the context of the data (including joint, marginal, and conditional relative frequencies). Recognize possible associations and trends in the data.</td><td>• Analyze a two-way frequency table to determine joint, marginal and conditional relative frequencies</td><td>Students may use spreadsheets, graphing calculators, and statistical software to create frequency tables and determine associations or trends in the data.

Examples:

Two-way Frequency Table
A two-way frequency table is shown below displaying the relationship between age and baldness. We took a sample of 100 male subjects, and determined who is or is not bald. We also recorded the age of the male subjects by categories.

<table>
<tr><td colspan="4">Two-way Frequency Table</td></tr>
<tr><td>Bald</td><td colspan="2">Age</td><td>Total</td></tr>
<tr><td></td><td>Younger than 45</td><td>45 or older</td><td></td></tr>
<tr><td>No</td><td>35</td><td>11</td><td>46</td></tr>
<tr><td>Yes</td><td>24</td><td>30</td><td>54</td></tr>
<tr><td>Total</td><td>59</td><td>41</td><td>100</td></tr>
</table>

The total row and total column entries in the table above report the marginal frequencies, while entries in the body of the table are the joint frequencies.

Two-way Relative Frequency Table
The relative frequencies in the body of the table are called conditional relative frequencies.</td><td></td></tr>
</table>

		Two-way Relative Frequency Table <table><tr><td>Bald</td><td colspan="2">Age</td><td>Total</td></tr><tr><td></td><td>Younger than 45</td><td>45 or older</td><td></td></tr><tr><td>No</td><td>0.35</td><td>0.11</td><td>0.46</td></tr><tr><td>Yes</td><td>0.24</td><td>0.30</td><td>0.54</td></tr><tr><td>Total</td><td>0.59</td><td>0.41</td><td>1.00</td></tr></table>	
6. Represent data on two quantitative variables on a scatter plot, and describe how the variables are related. a. Fit a function to the data; 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, quadratic, and exponential models. b. Informally assess the fit of a function by plotting and analyzing residuals. c. Fit a linear function for a scatter plot that suggests a linear association	• Given a function create a scatter plot and describe the relationship between the variables • Determine how the variables are related to each other in given sets • Fit functions to data • Calculate regressions and calculate residuals	The residual in a regression model is the difference between the observed and the predicted y for some x(y the dependent variable and $x$the independent variable). So if we have a model $y = ax + b$, and a data point (x_i, y_i) the residual is for this point is: $r_i = y_i - (ax_i + b)$. Example: • Measure the wrist and neck size of each person in your class and make a scatterplot. Find the least squares regression line. Calculate and interpret the correlation coefficient for this linear regression model. Graph the residuals and evaluate the fit of the linear equations.	

Math Curriculum
Algebra I

Essential Question(s): How can we use mathematical models to make predictions and informed decisions based on past data and trends?			
21st Century Theme: Financial, Economic, Business, and Entrepreneurial Literacy			
21st Century Skills: Critical Thinking and Problem Solving			
Content: Statistics and Probability- *Interpreting Categorical and Quantitative Data			
Standards: S.ID			
C. Interpret linear models.			
Vocabulary: slope, intercept, rate of change, correlation coefficient, correlation, causation			
Skills	**Instructional Procedures**	**Explanations and Examples**	**Interdisciplinary Connections**
7. Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.	• Explain rate of change for a given linear equation • Determine x and y intercepts	Students will use computer assisted technology to create representations of data sets and create linear models. Example: • Lisa lights a candle and records its height in inches every hour. The results recorded as (time, height) are (0, 20), (1, 18.3), (2, 16.6), (3, 14.9), (4, 13.2), (5, 11.5), (7, 8.1), (9, 4.7), and (10, 3). Express the candle's height (*h*) as a function of time (*t*) and state the meaning of the slope and the intercept in terms of the burning candle. Solution: $h = -1.7t + 20$ Slope: The candle's height decreases by 1.7 inches for each hour it is burning. Intercept: Before the candle begins to burn, its height is 20 inches.	
8. Compute (using technology) and interpret the correlation coefficient of a linear fit.	• Given the set of data, describe how the variables are related • Fit functions to data, • Perform regressions, • Calculate residuals and correlation coefficients	Students will use computer assisted software to represent data, describe how the variables are related, fit functions to data, perform regressions, and calculate residuals and correlation coefficients. Example: Collect height, shoe-size, and wrist circumference data for each student. Determine the best way to display the data. • Is there a correlation between any two of the three indicators? • Is there a correlation between all three indicators? • What patterns and trends are apparent in the data? • What inferences can be made from the data?	

9. Distinguish between correlation and causation.	• Define correlation and causation • Provide logical examples to illustrate the difference between correlation and causation	Some data leads observers to believe that there is a cause and effect relationship when a strong relationship is observed. Students should be careful not to assume that correlation implies causation. The determination that one thing causes another requires a controlled randomized experiment. Example: Diane did a study for a health class about the effects of a student's end-of-year math test scores on height. Based on a graph of her data, she found that there was a direct relationship between students' math scores and height. She concluded that "doing well on your end-of-course math tests makes you tall." Is this conclusion justified? Explain any flaws in Diane's reasoning.	