Wilmette Public Schools, District 39
Grade 8 Algebra Curriculum

Statement of Philosophy

District 39 believes in a focused, coherent, and rigorous study of mathematics that encourages students to develop perseverance. Application of mathematical ideas emerges through the development of conceptual understanding and procedural fluency. Through evidence-based arguments and critiques, students engage in mathematical discourse. Students represent their ideas in multiple modalities and explore mathematical connections within the world around them.

Best Practices in Mathematics Education

Best instructional practices in a mathematics classroom should:

- provide concepts-based instruction rather than skills-based instruction.
- address conceptual understanding and develop procedural literacy.
- differentiate instruction to meet the needs of the varied learners in the classroom.
- connect and integrate with other disciplines and the real world.
- allow for exploration, explanation, and evaluation of progress.
- ask probing questions which require students to justify their responses.
- encourage students to work cooperatively with others.
- accept divergent ideas and promote the sharing of these ideas.
- use multiple representations to communicate understandings of mathematical ideas.
- provide opportunities for supporting and challenging mathematical thinking and strategic thinking skills.
- promote strategic competence through meaningful problem-solving investigations.
- build on students' emerging capabilities by using concrete models to bridge understandings of mathematics toward more abstract reasoning and thinking.

Mathematical Practices

MP1 Make sense of problems and persevere in solving them.
MP2 Reason abstractly and quantitatively.
MP3 Construct viable arguments and critique the reasoning of others.
MP4 Model with mathematics.
MP5 Use appropriate tools strategically.
MP6 Attend to precision.
MP7 Look for and make use of structure.
MP8 Look for and express regularity in repeated reasoning.

For more detailed descriptions:
http://www.corestandards.org/Math/Practice

Modes of Representation

1. Manipulative Models
2. Pictures/Graphs
3. Written Symbols
4. Oral/Written Language
5. Real-Life Situation

Conceptual understanding is demonstrated through the ability to express understanding through a variety of representations as well as the ability to convert from one mode to another mode of representation.

Big Ideas of Mathematics

- Math is a universal language with a unified system of symbols that can be used to explore ideas and connect the world.
- Math is indispensable in developing problem solving, reasoning, strategic and critical skills.
- Math is about making sense of the world through patterns and quantitative relationships.
- Math is like ladders that build in complexity with concrete and abstract ideas.

Essential Questions

- How do we make sense of the world using and applying mathematics?
- How can we use mathematics to communicate?
- How is math coherent?

Grade 8 Required Fluency Expectations

Fluently solve systems of linear equations and inequalities.
Fluently transform algebraic expressions.

Critical Areas in Grade 8 Algebra

http://www.corestandards.org/Math; www.parcconline.org

In Grade 8 Algebra, instructional time should focus on seven critical areas:

1. Students use linear equations and systems of linear equations to represent, analyze, and solve a variety of problems. Students recognize equations for proportions ($y/x = m$ or $y = mx$) as special linear equations

(y = mx + b), understanding that the constant of proportionality (m) is the slope, and the graphs are lines through the origin. They understand that the slope (m) of a line is a constant rate of change, so that if the input or x-coordinate changes by an amount A, the output or y-coordinate changes by the amount m·A. Students also use a linear equation to describe the association between two quantities in bivariate data (such as arm span vs. height for students in a classroom). At this grade, fitting the model, and assessing its fit to the data are done informally. Interpreting the model in the context of the data requires students to express a relationship between the two quantities in question and to interpret components of the relationship (such as slope and y-intercept) in terms of the situation.

2. Students understand the statement of the Pythagorean Theorem and its converse, and can explain why the Pythagorean Theorem holds, for example, by decomposing a square in two different ways. They apply the Pythagorean Theorem to find distances between points on the coordinate plane, to find lengths, and to analyze polygons.
3. Students will begin to understand the real number system.
4. By grade 7, students begin to recognize that rewriting expressions in different forms could be useful in problem solving. In Algebra 1, these aspects of algebra carry forward as students continue to use properties of operations to rewrite expressions, gaining fluency and engaging in what has been called “mindful manipulation”.
5. Students will master linear and quadratic functions. Students encounter other kinds of functions to ensure that general principles are perceived in generality, as well as to enrich the range of quantitative relationships considered in problems.
6. As students acquire mathematical tools from their study of algebra and functions, they apply these tools in statistical contexts. In a modeling context, they might informally fit a quadratic function to a set of data, graphing the data and model function on the same coordinate axes.
7. Students will solve real-world problems using algebra techniques.

Unit 1: Relationships between Quantities and Reasoning with Equations		
Domain-specific vocabulary: rational, irrational, decimal expansion, approximations, line diagram, scale, origin, descriptive modeling, terms, factors, coefficients, linear equation, inequality, variable, real numbers, expressions, transform, polynomial, x-intercept, functions, decomposition, literal equations, literal inequalities, factorization, intercepts, maxima, minima		
Illinois Learning Standards **Priority (70%)** **Supporting (20%)** **Additional (10%)**	**Prerequisite Skills**	**Conceptual & Formative Understandings**
8.NS.1 Know that numbers that are not rational are called irrational. Understand informally that every number has a decimal expansion; for rational numbers show that the decimal expansion repeats eventually, and convert a decimal expansion, which repeats eventually into a rational number. 8.NS.2 Use rational approximations of irrational numbers to compare the size of irrational numbers, locate them approximately on a number line diagram, and estimate the value of expressions. For example, by truncating the decimal expansion of $\sqrt{2}$, show that $\sqrt{2}$ is between 1 and 2, then between 1.4 and 1.5, and explain how to continue on to get better approximations. N.Q.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. N.Q.2 Define appropriate quantities for the purpose of descriptive modeling. N.Q.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. A.SSE.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. A.CED.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.★ A.REI.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. A.REI.3: Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters. (EOY)	***Students should already be able to…*** (8.NS.1 and 8.NS.2) • Perform operations with rational numbers including negative rational numbers. (7.NS) • Rewrite expressions in different forms. (7.EE.2) (N.Q.1, N.Q.2, N.Q.3, A.SSE.1, A.REI.3) • Solve linear equations in one variable with rational number coefficients. • Understand the connections between proportional relationships, lines and linear equations. (A.SSE.1a, A.CED.1, A.CED.2, A.CED.3., A.CED.4, F.IF.4., F.IF.5, F.IF.6, F.IF.7, F.BF.1, A.REI.12) • Graph a line, given its equation or a list of ordered pairs. • Use linear equations/inequalities to solve problems.	**Conceptual Understandings:** ***Students will understand that . . .*** (8.NS.1 and 8.NS.2) • Every number has a decimal expansion. • Properties of operations with whole and rational numbers also apply to all real numbers. (N.Q.1, N.Q.2, N.Q.3, A.SSE.1a, A.REI.3) • The different parts of expressions, equations and inequalities can represent certain values in the context of a situation and help determine a solution process. • Relationships between quantities can be represented symbolically, numerically, graphically, and verbally in the exploration of real world situations. • Rules of arithmetic and algebra can be used together with notions of equivalence to transform equations and inequalities. • Equivalent forms of an expression can be found, dependent on how the expression is used. (A.SSE.2, A.CED.1, A.CED.2, A.REI.1, F.IF.4, F.IF.6, F.IF.7, F.IF.9, A.REI.11, F.BF.3, F.BF.4a) • The degree of a polynomial helps to determine the end behavior of its graph. • The zeroes of each factor of a polynomial determine the x-intercepts of its graph. • Graphs of rational functions are often discontinuous, due to values that are not in the domain of the function. (A.SSE.1, A.CED.1, A.CED.2, A.CED3., A.CED.4, F.IF.4., F.IF.5, F.IF.6, F.IF.7abe, F.BF.1ab, A.REI.12) •Linear models can be created, used, and interpreted for real-life situations. **Formative Understandings (Skills)** ***Students will be able to…*** • Distinguish between rational and irrational numbers. (8.NS.1) • Convert a decimal expansion that repeats eventually into a rational number. (8.NS.1) • Find rational approximations of irrational numbers. (8.NS.2) • Use rational approximations of irrational numbers to compare the size of irrational numbers, locate them approximately on a number line, and estimate the value of expressions. (8.NS.2) (N.Q.1, N.Q.2, N.Q.3, A.SSE.1ab, A.REI.3) • Identify the different parts of the expression and explain their meaning within context. (i.e. terms, factors, coefficients, constants, exponents). • Define, explain and describe the components of a complicated expression using decomposition. • Solve linear equations in one variable, including literal equations. • Solve linear inequalities in one variable, including literal inequalities

		(A.SSE.2, A.CED.1, A.CED.2, A.REI.1, F.IF.4, F.IF.6, F.IF.7abe, F.IF.9, A.REI.11, F.BF.3, F.BF.4a) • Graph a polynomial given in factored form, indicating all intercepts and directions of end behaviors. • Use the structure of an expression to identify ways to rewrite it. • Create equations in one or two variables and use them to solve problems. • Construct viable arguments to justify a solution method. • Calculate and interpret the average rate of change of a function. • Write the equation of a polynomial function given its graph or defining characteristics of its graph. • Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). • Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial. (A.SSE.1a, A.CED.1, A.CED.2, A.CED3., A.CED.4, F.IF.4., F.IF.5, F.IF.6, F.IF.7abe, F.BF.1ab, A.REI.12) • Interpret parts of expressions, such as terms, factors, and coefficients. • Determine for what range of values a linear model might be appropriate (restrictions on domain/range) for a given situation. • Estimate the rate of change over a specified interval. • Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or non-viable options in a modeling context. • Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. • Define appropriate quantities for the purpose of descriptive modeling. • Choose a level of accuracy appropriate to limitations of measurement when reporting quantities. • Graph linear and quadratic functions and show intercepts, maxima, and minima.

Unit 2: Linear Functions and Modeling

Domain-specific vocabulary: coordinate plane, linear equations, points of intersection, functions, functional relationship, linear, nonlinear, y-intercept, rational, polynomial, absolute value, exponential, logarithmic, equality, inequality, half-planes, domain, relative maximums, relative minimums, interval

Illinois Learning Standards

Priority (70%) **Supporting (20%)** **Additional (10%)**

8.EE.8 Analyze and solve pairs of simultaneous linear equations.

a. Understand that solutions to a system of two linear equations in two variables correspond to points of intersection of their graphs, because points of intersection satisfy both equations simultaneously.

b. Solve systems of two linear equations in two variables algebraically, and estimate solutions by graphing the equations. Solve simple cases by inspection. For example, $3x + 2y = 5$ and $3x + 2y = 6$ have no solution because $3x + 2y$ cannot simultaneously be 5 and 6.

c. Solve real-world and mathematical problems leading to two linear equations in two variables. For example, given coordinates for two pairs of points, determine whether the line through the first pair of points intersects the line through the second pair.

A.REI.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.

A.REI.6 Solve systems of linear equations exactly and approximately (e.g., with graphs), focusing on pairs of linear equations in two variables.

8.F.5 Describe qualitatively the functional relationship between two quantities by analyzing a graph (e.g., where the function is increasing or decreasing, linear or nonlinear). Sketch a graph that exhibits the qualitative features of a function that has been described verbally.

A-REI.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).

A-REI.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 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.

A-REI.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.

F-IF.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 $y = f(x)$.

F-IF.2 Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of a context.

F-IF.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 $n \geq 1$.

F-IF.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.★

Prerequisite Skills

Students should already be able to…

(8.F.1, 8.F.3, 8.F.5)

- Use independent and dependent variables. (6.EE.9)
- Use characteristics of proportional relationship and have an informal understanding of slope. (7.RP.1-3)
- Use the coordinate plane.
- (8.EE.8)
- Determine unit rate.
- Apply proportional relationships.
- Solve equations with numeric and graphical representations of solutions.
- Calculate slope/rate of change.

(F.IF.1-6)

- Evaluate expressions such as $(-3)^2 +4(-3) + 8$
- Understand variables, independent and dependent quantities.
- Define function.
- Graph coordinate pairs and simple functions.
- Understand and evaluate f(x).
- Represent functions in multiple way**s**.

(A.CED.3, A.REI.11, A.REI.12, A.REI.5, A.REI.6)

- Read and write inequality symbols.
- Graph equations and inequalities on the coordinate plane.
- Find the slope of a line.
- Evaluate expressions.
- Construct a table of values.

(A.SSE.1ab, A.REI.10, F.IF.3, F.IF.9, F.BF.2, F.LE.1abc, F.LE.2)

- Solve one variable equations using the properties of equivalency.
- Model real-world context with one- or two-variable equations.
- Define a function and the parts of expressions, equations and functions.

(F.IF.4, F.IF.5, F.IF.6, F.IF.7abe, F.IF.8ab, F.IF.9, A.CED.1, F.LE.3, F.LE.5,S.ID.6abc, A.SSE.3abc, F.BF.3, F.BF.1ab)

- Solve one-variable equations and recognize equivalent forms.
- Model real-world one-variable equations and two-variable equations limited to linear.
- Define a function and distinguish between coefficients, factors and terms.
- Recognize how functions can be represented on a graph and in a table and how scale and labels can modify the appearance of the representation.
- Represent real-world situations with a linear model.
- Represent data on a scatter plot both by hand and with technology.
- Represent linear on a graph or table and explain how scale and labels can change the look of a representation.

Conceptual & Formative Understandings

Conceptual Understandings:

Students will understand that . . .

(8.F.1, 8.F.3, 8.F.5)

- A function is a specific topic of relationship in which each input has a unique output that can be represented in a table.
- A function can be represented graphically using ordered pairs that consist of the input and the output of the function in the form (input, output).
- A function can be represented with an algebraic rule.
- The equation $y = mx + b$ is a straight line and that slope and y-intercept are critical to solving real problems involving linear relationships.
- Changes in varying quantities are often related by patterns, which can be used to predict outcomes and solve problems.
- Linear functions may be used to represent and generalize real situations

(8.EE.8)

- Unit rates can be explained in graphical representation, algebraic equations, and in geometry through similar triangles.
- The solution to a system of two linear equations in two variables is an ordered pair that satisfies both equations.
- Some systems of equations have no solutions (parallel lines) and others have infinite solutions (be the same line).

(F.IF.1-6)

- Functions have exactly one output for each input.
- Functions can be defined explicitly or recursively.
- Function notation is used to evaluate and interpret inputs and outputs of functions.
- Sequences are functions with a domain as a subset of the integer.
- A function has key features that can be represented and interpreted from a graph, table or quantitative relationship.
- Functions can be used as models and can be represented as equations, tables, graphs, and words.
- Given a particular representation (such as an equation) of a function, other representations (such as graphs or tables) can be generated and explored.
- Functions exhibit special properties that can be identified and used to compare functions or to determine solutions to real world experiences.
- Transformations allow for quick manipulations and graphing of functions.
- Average rate of change can be calculated, estimated and/or interpreted from multiple representations of a function.

(A.CED.3, A.REI.11, A.REI.12, A.REI.5, A.REI.6)

- Real world situations can be modeled by systems of linear equations or inequalities.
- A system of equations can have no, one, or infinitely many solutions.
- Solutions of systems of equations are ordered pairs that satisfy all equations.
- Solutions of systems of inequalities are ordered pairs that satisfy all inequalities, often represented by a region.

F-IF.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.★ F-IF.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.★ F-IF.7A 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. F-IF.9 (EOY)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. F.BF.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. F.BF.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. F.LE.1 Distinguish between situations that can be modeled with linear functions and with exponential functions.★ 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. F.LE.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) F.LE.3 (EOY) Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function. F.LE.5 (EOY) Interpret the parameters in a linear or exponential function in terms of a context.		• Exact or approximate solutions can be found using tables, graphs, and/or algebraic manipulations. (A.SSE.1a, A.REI.10, F.IF.3, F.IF.9, F.BF.2, F.LE.1abc, F.LE.2) • Arithmetic and geometric sequences both have a domain of the integers, but arithmetic sequences have equal intervals (common difference) and • geometric have equal factors (constant ratio). • Geometric sequences can be represented by both recursive and explicit formulas. • Exponential functions can be represented by a table, graph, verbal description or equation. Each representation can be transferred to another • representation. • Discrete and continuous functions have properties that appear differently when graphed. • Exponential expressions represent a quantity in terms of its context. • Exponential expressions have equivalent forms that can reveal new information to aid in solving problems. (F.IF.4, F.IF.5, F.IF.6, A.CED.1, F.BF.1ab, F.LE.3, F.LE.5, A.SSE.3abc) • Exponential functions, like linear, can be used to model real-life situations. • Key features in graphs and tables shed light on relationships between two quantities. • Differences between linear and exponential functions, thus allowing them to use the appropriate model. • Units, scale, data displays, and levels of accuracy represented in situations. • Functions can be created to best-fit data represented on a scatter plot. (F.IF.6, F.IF.7abe, F.IF.8ab, F.IF.9, S.ID.6abc, A.SSE.3, F.BF.3abc, F.BF.1ab) • Quadratic functions have key features that can be represented on a graph and can be interpreted to provide information to describe relationships of two • quantities. These graphs can be compared to linear and exponential functions to model a situation. • The meaning of average rate of change of a quadratic model is interpreted based upon the context. • Quadratic expressions have equivalent forms that can reveal new information to aid in solving problems. • Data can be represented on and interpreted from a scatter plot. • Equations are affected by transformations of a graph and vice versa. **Formative Understandings (Skills)** ***Students will be able to…*** • Verify that a relationship is a function or not. (8.F.1) • Reason from a context, graph, or table after knowing which quantity is the input and which is the output. (8.F.1) • Interpret equations in y = mx + b form as a linear function. (8.F.3) • Determine whether a function is linear or non-linear. (8.F.3) • Describe the qualities of a function using a graph (e.g., where the function is increasing or decreasing). (8.F.5) • Sketch a graph when given a verbal description of a situation. (8.F.5) • Determine whether a relationship is linear. (8.EE.8) • Estimate solutions by graphing equations. (8.EE.8) • Solve systems by graphing, substitution, or elimination (combination). (8.EE.8) • Determine if a system has one solution, no solutions, or many solutions. (8.EE.8) • Interpret the solution to a system of equations in context. (8.EE.8)

		(F.IF.1-6) • Use function notation and interpret statements that use function notation in terms of a context. • Identify functions from a variety of representations. • Evaluate f(x) for many functions. • Translate between symbolic representations of functions and tables or graphs. • Find outputs given inputs and inputs given outputs. • Relate the domain of a function to its graph and to the context. • Interpret key features of a function represented as a graph or a table. • Sketch graphs showing key features given a verbal description of the relationship. • Calculate and interpret the average rate of change of a function over a specified interval. • Estimate the rate of change from a graph. • Create a table and a graph given the equation of a function. • Identify the context domain and corresponding range of a function model. • Use and interpret a table, graph, or equation to determine critical features of a function and to relate these back to the real context. • Explain the features of a function in relation to its context and to its mathematical structure. • Calculate average rate of change as represented in equations, tables, or graphs. • Compare functions represented in various ways. • Relate values of a function back to the original context. • Graph a function using basic transformations. • Compare transformations that preserve distance and angle to those that do not. (A.CED.3, A.REI.11, A.REI.12, A.REI.5, A.REI.6) • Write a system of linear equations in two variables to model a situation. • Determine if an ordered pair is a solution to a system and interpret the viability of solutions. • Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or non-viable options in a modeling context. • 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. • Solve a system of two equations or inequalities graphically, using tables, algebraically or with technology. • 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. (A.SSE.1ab, A.REI.10, F.IF.3, F.IF.9, F.BF.2, F.LE.1ab, F.LE.2) • Write recursive and explicit equations for arithmetic and geometric functions. • Create tables or other representations given recursive or explicit equations for sequences. • Recognize patterns in exponential functions and geometric sequences. • Model situations using explicit and recursive equations. Translate among representations of exponential functions including tables, graphs, equations and real-life situations. • Distinguish between linear and exponential functions from multiple representations. (F.IF.4, F.IF.5, F.IF.6, A.CED.1, F.BF.1ab, F.LE.3, F.LE.5, A.SSE.3abc) • Translate between representations of exponential functions including tables, graphs, equations and real-life situations. • Distinguish between linear and exponential functions from multiple representations. • Rewrite exponential functions to reveal new information.

		• Use functions fitted to data to solve problems in the context of the data. • Interpret the parameters in a linear or exponential function in terms of a context. • Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. • 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. • Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly. (F.IF.6, F.IF.7, F.IF.8, F.IF.9, S.ID.6abc, A.SSE.3abc, F.BF.3, F.BF.1ab) • Write a quadratic equation and/or function to model a real-life situation. • Use a model of a quadratic function to interpret information about a real-life situation. • Use and compare multiple representations of quadratic functions including tables, graphs, equations and real-life situations. • Distinguish between linear, exponential and quadratic functions from multiple representations. • Rewrite quadratic and exponential functions in different forms to reveal new information. • Estimate, calculate and interpret average rate of change over a specified interval. • Compare two functions represented in different ways (such as an equation compared to a table or graph). • Fit a linear, quadratic, or exponential model to data. • Assess the fit of a model to data by analyzing residuals and residual plots. • Transform graphs based on changes in equations and write equations based on a transformed parent graph.

Unit 3: Exponential Functions and Modeling

Domain-specific vocabulary: properties of integer exponents, scientific notation, radicals, rational exponents, exponential growth and decay, parameters

Illinois Learning Standards **Priority (70%)** **Supporting (20%)** **Additional (10%)**	Prerequisite Skills	Conceptual & Formative Understandings
8.EE.1 Know and apply the properties of integer exponents to generate equivalent numerical expressions. *For example,* $3^2 \times 3^{-5} = 3^{-3} = 1/3^3 = 1/27$. 8.EE.2 Use square root and cube root symbols to represent solutions to equations of the form $x^2 = p$ and $x^3 = p$, where p is a positive rational number. Evaluate square roots of small perfect squares and cube roots of small perfect cubes. Know that π is irrational. 8.EE.3 Use numbers expressed in the form of a single digit times an integer power of 10 to estimate very large or very small quantities, and to express how many times as much one is that the other. *For example, estimate the population of the United States as* 3×10^8 *and the population of the world as* 7×10^9*, and determine that the world population is more than 20 times larger.* 8.EE.4 Perform operations with numbers expressed in scientific notation, including problems where both decimal and scientific notation are used. Use scientific notation and choose units of appropriate size for measurements of very large or very small quantities (e.g., use millimeters per year for seafloor spreading). Interpret scientific notation that has been generated by technology. N.RN.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 51/3 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. N.RN.2 Rewrite expressions involving radicals and rational exponents using the properties of exponents. 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.★ b. Graph square root, cube root, and piecewise-defined functions, including step functions and absolute value functions. e. Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude. F.IF.8B Use the properties of exponents to interpret expressions for exponential functions. For example, identify percent rate of change in functions such as $y = (1.02)^t$, $y = (0.97)^t$, $y = (1.01)12^t$, $y = (1.2)^t/10$, and classify them as representing exponential growth or decay. A-SSE.3 Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression. c. Use the properties of exponents to transform expressions for exponential functions. *(The following standards are introduced in Unit 2)* *F-LE.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.* *F-LE.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)* *F.LE.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.* *F.LE.5 Interpret the parameters in a linear or exponential function in terms of a context.*	***Students should already be able to…*** • Perform operations with rational numbers including negative rational numbers. (7.NS) • Rewrite expressions in different forms. (7.EE.2) (N.RN.1, N.RN.2., N.RN.3, A.CED.1) • Apply the properties of integer exponents. • Recognize radical notation. • Recognize an irrational number. • Write rational numbers as terminating or repeating decimals. • Write irrational numbers as non-terminating, non-repeating decimals. • Solve linear equations. (F.IF.6, F.IF.7abe, F.IF.8ab, F.IF.9, S.ID.6abc, A.SSE.3abc, F.BF.3, F.BF.1ab) • Solve one-variable equations and recognize equivalent forms. • Model real-world one-variable equations and two-variable equations limited to linear. • Define a function and distinguish between coefficients, factors and terms. • Recognize how functions can be represented on a graph and in a table and how scale and labels can modify the appearance of the representation. • Represent real-world situations with a linear model and make decisions about the appropriateness. • Represent data on a scatter plot both by hand and with technology. (A.SSE.1ab, A.REI.10, F.IF.3, F.IF.9, F.BF.2, F.LE.1abc, F.LE.2) • Solve one variable equations using the properties of equivalency. • Model real-world context with one- or two-variable equations. • Define a function and the parts of expressions, equations, and functions. • Represent and interpret functions on a graph and in a table using scale and labels appropriately. • Write arithmetic sequences and linear functions and represent them in multiple ways. (F.IF.4, F.IF.5, F.IF.6, A.CED.1, F.BF.1, F.LE.3, F.LE.5, A.SSE.3) • Solve one-variable equations using the properties of equivalency. • Define a function and the different parts in expressions, equations and functions. • Represent linear functions on a graph or table and explain how scale and labels can change the look of a representation.	**Conceptual Understandings:** ***Students will understand that . . .*** (8.EE.1-4) • The value of any real number can be represented in relation to other real numbers such as with decimals converted to fractions, scientific notation and numbers written with exponents ($8 = 2^3$). (N.RN.1, N.RN.2., N.RN.3, A.CED.1) • Radical expressions can be written equivalently using rational exponents. • Properties of integer exponents may be applied to expressions with rational exponents. • Adding and multiplying two rational numbers results in a rational number. • The result of adding a rational number and an irrational number is an irrational number. • The result of multiplying a non-zero rational number to an irrational number is an irrational number. (F.IF.6, F.IF.7ab, F.IF.8ab, F.IF.9, S.ID.6ab, A.SSE.3abc, F.BF.3, F.BF.1ab) • Quadratic functions have key features that can be represented on a graph and can be interpreted to provide information to describe relationships of two quantities. These graphs can be compared to linear and exponential functions to model a situation. • The meaning of average rate of change of a quadratic model is interpreted based upon the context. • Quadratic expressions have equivalent forms that can reveal new information to aid in solving problems. • Data can be represented on and interpreted from a scatter plot. • Equations are affected by transformations of a graph and vice versa. (A.SSE.1ab, A.REI.10, F.IF.3, F.IF.9, F.BF.2, F.LE.1abc, F.LE.2) • Arithmetic and geometric sequences both have a domain of the integers, but arithmetic sequences have equal intervals (common difference) and • geometric have equal factors (constant ratio). • Geometric sequences can be represented by both recursive and explicit formulas. • Exponential functions can be represented by a table, graph, verbal description or equation. Each representation can be transferred to another • representation. • Discrete and continuous functions have properties that appear differently when graphed. • Exponential expressions represent a quantity in terms of its context. • Exponential expressions have equivalent forms that can reveal new information to aid in solving problems. (F.IF.4, F.IF.5, F.IF.6, A.CED.1, F.BF.1ab, F.LE.3, F.LE.5, A.SSE.3abc) • Exponential functions, like linear, can be used to model real-life situations. • Key features in graphs and tables shed light on relationships between two quantities. • Differences between linear and exponential functions, thus allowing them to use the

F-IF.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.★ *F-IF.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.★* *F-IF.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.★* *F-IF.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.* *F-BF.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.* *F.BF.2 Write arithmetic and geometric sequences both recursively and with an explicit formula, use them to model situations, and translate between the two forms.** *F-BF.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.*		appropriate model. • Units, scale, data displays, and levels of accuracy represented in situations. • Functions can be created to best-fit data represented on a scatter plot. **Formative Understandings (Skills)** ***Students will be able to…*** • Evaluate square roots of small perfect squares and cube roots of small perfect cubes. (8.EE.2) • Use square root and cube root symbols to solve and represent solutions of equations. (8.EE.2) • Apply the properties of integer exponents to generate equivalent numerical expressions. (8.EE.1) • Estimate very large or very small quantities using a single digit times a power of ten. (8.EE.3) • Express how much larger one number expressed as a single digit times a power of ten is than another in the context of the situation. (8.EE.3) • Express numbers in scientific notation. (8.EE.4) • Perform operations with numbers expressed in scientific notation and a mix of scientific notation and decimal notation. (8.EE.4) • Choose appropriate units of measurements for a given number in scientific notation. (8.EE.4) • Interpret scientific notation that has been generated by technology. (8.EE.4) (N.RN.1, N.RN.2., N.RN.3, A.CED.1) • Apply the properties of exponents to algebraic expressions with integer exponents. • Apply the properties of exponents to algebraic expressions with rational exponents. • Write radical expressions as expressions with rational exponents. • Write expressions with rational exponents as radical expressions. • Write an exponential equation or inequality that models a given context. • Solve an exponential equation or inequality. • Interpret the solution of an equation or inequality in the context of the problem (F.IF.6, F.IF.7, F.IF.8, F.IF.9, S.ID.6, A.SSE.3, F.BF.3, F.BF.1ab) • Write a quadratic equation and/or function to model a real-life situation. • Use a model of a quadratic function to interpret information about a real-life situation. • Use and compare multiple representations of quadratic functions including tables, graphs, equations and real-life situations. • Distinguish between linear, exponential and quadratic functions from multiple representations. • Rewrite quadratic and exponential functions in different forms to reveal new information. • Estimate, calculate and interpret average rate of change over a specified interval. • Compare two functions represented in different ways (such as an equation compared to a table or graph). • Fit a linear, quadratic, or exponential model to data. • Assess the fit of a model to data by analyzing residuals and residual plots. • Transform graphs based on changes in equations and write equations based on a transformed parent graph. (A.SSE.1, A.REI.10, F.IF.3, F.IF.9, F.BF.2, F.LE.1, F.LE.2) • Write recursive and explicit equations for arithmetic and geometric functions. • Create tables or other representations given recursive or explicit equations for sequences.

		• Recognize patterns in exponential functions and geometric sequences. • Model situations using explicit and recursive equations. Translate among representations of exponential functions including tables, graphs, equations and real-life situations. • Distinguish between linear and exponential functions from multiple representations. (F.IF.4, F.IF.5, F.IF.6, A.CED.1, F.BF.1, F.LE.3, F.LE.5, A.SSE.3abc) • Translate between representations of exponential functions including tables, graphs, equations and real-life situations. • Distinguish between linear and exponential functions from multiple representations. • Rewrite exponential functions to reveal new information. • Use functions fitted to data to solve problems in the context of the data. • Interpret the parameters in a linear or exponential function in terms of a context. • Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. • 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. • Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly

Unit 4: Polynomial Expressions and Quadratic Equations

Domain-specific vocabulary: linear models, polynomial expression, quadratic equation, factors, x-intercept, y-intercept

Illinois Learning Standards Priority (70%) Supporting (20%) Additional (10%)	Prerequisite Skills	Conceptual & Formative Understandings
A.SSE.2 Use the structure of an expression to identify ways to rewrite it. A.SSE.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. A.APR.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. A.CED.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.★ A.CED.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.★ A.CED.3 Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or non-viable options in a modeling context. For example, represent inequalities describing nutritional and cost constraints on combinations of different foods. A.REI.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 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 ± bi for real numbers a and b.23 A.REI.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 $x^2 + y^2 = 3$. *(The following standard is introduced in Unit 1)* *A.SSE.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.*	***Students should already be able to…*** (A.SSE.1ab, A.CED.1ab, A.CED.2, A.CED3., A.CED.4, F.IF.4., F.IF.5, F.IF.6, F.IF.7abe, F.BF.1ab, A.REI.12) • Graph a line, given its equation or a list of ordered pairs. • Write a linear equation or inequality, given two ordered pairs or slope and one ordered pair. • Use linear equations/inequalities to solve problems. • Translate among representations of linear functions including tables, graphs, equations and real-life situations. • Use technology to graph lines, changing the viewing window as necessary to show and determine intercepts. (A.SSE.1ab, A.SSE.2, A.SSE.3, A.CED.1, A.CED.2, F.IF.6, F.IF.7abe, F.IF.8ab, F.IF.9, A.APR.1) • Perform algebraic operations on and simplify linear expressions. • Calculate rate of change. • Graph linear functions. (A.CED.3, A.REI.11, A.REI.12, A.REI.5, A.REI.6) • Read and write inequality symbols. • Graph equations and inequalities on the coordinate plane. • Find the slope of a line. • Evaluate expressions. • Construct a table of values.	**Conceptual Understandings:** ***Students will understand that . . .*** (A.SSE.1ab, A.CED.1, A.CED.2, A.CED3., A.CED.4, F.IF.4., F.IF.5, F.IF.6, F.IF.7abe, F.BF.1ab, A.REI.12) • Linear models can be created, used, and interpreted for real-life situations. (A.SSE.2, A.CED.1, A.CED.2, A.REI.1, F.IF.4, F.IF.6, F.IF.7abe, F.IF.9, A.REI.11, F.BF.3, F.BF.4a) • The degree of a polynomial helps to determine the end behavior of its graph • The zeroes of each factor of a polynomial determine the x-intercepts of its graph • (A.SSE.1ab, A.SSE.2, A.SSE.3abc, A.CED.1, A.CED.2, F.IF.6, F.IF.7abe, F.IF.8ab, F.IF.9, A.APR.1) • Polynomial expressions can be added, subtracted, and multiplied to produce new polynomials. • The factors of a quadratic can be used to reveal the zeros of the quadratic. • The process of completing the square can be used to reveal the vertex of the graph of a quadratic (and consequently the minimum or maximum of the function). • The graph of a quadratic function is a curve called a parabola which will have an interval of increase, an interval of decrease, a minimum or maximum, a y-intercept, and which may or may not have x-intercepts. (A.SSE.1ab, A.SSE.2, A.SSE.3abc, A.REI.1, A.REI.4ab, A.REI.7) • Applied problems using quadratics can be answered by either solving a quadratic equation or re-writing the quadratic in a more useful form (factoring to find the zeros, or completing the square to find the maximum or minimum, for instance). • There are several ways to solve a quadratic equation (square roots, completing the square, quadratic formula, and factoring), and that the most efficient route to solving can often be determined by the initial form of the equation. • The quadratic formula is derived from the process of completing the square. (A.CED.3, A.REI.11, A.REI.12, A.REI.5, A.REI.6) • Real world situations can be modeled by systems of linear equations or inequalities. • A system of equations can have no, one, or infinitely many solutions. • Solutions of systems of equations are ordered pairs that satisfy all equations. • Solutions of systems of inequalities are ordered pairs that satisfy all inequalities, often represented by a region. • Exact or approximate solutions can be found using tables, graphs, and/or algebraic manipulations **Formative Understandings (Skills)** ***Students will be able to…*** (A.SSE.1, A.CED.1, A.CED.2, A.CED3., A.CED.4, F.IF.4., F.IF.5, F.IF.6, F.IF.7, F.BF.1, A.REI.12) • Interpret parts of expressions, such as terms, factors, and coefficients. • Determine for what range of values a linear model might be appropriate (restrictions on domain/range) for a given situation.

		• Estimate the rate of change over a specified interval. • Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or non-viable options in a modeling context. • Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. • Define appropriate quantities for the purpose of descriptive modeling. • Choose a level of accuracy appropriate to limitations of measurement when reporting quantities. • Graph linear and quadratic functions and show intercepts, maxima, and minima. (A.SSE.2, A.CED.1, A.CED.2, A.REI.1, A.REI.2, F.IF.4, F.IF.6, F.IF.7abe, F.IF.9, A.REI.11, F.BF.3, F.BF.4a) • Graph a polynomial given in factored form, indicating all intercepts and directions of end behaviors. • Use the structure of an expression to identify ways to rewrite it. • Create equations in one or two variables and use them to solve problems. • Construct viable arguments to justify a solution method. • Calculate and interpret the average rate of change of a function. • Identify the effect on the graph of replacing f(x) by f(x) + k, kf(x), f(kx) and f(x+k) • Write the equation of a polynomial function given its graph or defining characteristics of its graph. • Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). (A.SSE.1ab, A.SSE.2, A.SSE.3ab, A.CED.1, A.CED.2, F.IF.6, F.IF.7abe, F.IF.8ab, F.IF.9, A.APR.1) • Add, subtract, and multiply polynomials. • Interpret expressions in terms of its context. • View complicated expressions by its parts. • Calculate the average rate of change of a quadratic over a certain interval, given a function, table, or graph. • Use the structure of an expression to identify ways to rewrite it. • Factor a quadratic expression. • Complete the square on a quadratic function. • Show zeros, extreme values, and symmetry of the graph of a quadratic function, and interpret these in terms of a context. • Create equations in one, two or more variables to represent relationships between quantities. • Graph a quadratic function and show intercepts, maxima and minima. • Compare properties of two quadratic functions each represented in a different way (algebraically, graphically, numerically in tables or by verbal descriptions). (A.SSE.1ab, A.SSE.2, A.SSE.3abc, A.REI.1, A.REI.4ab, A.REI.7) • Define appropriate quantities when modeling. • Explain their reasoning in solving equations. • Solve quadratic equations by taking square roots. • Solve quadratic equations by completing the square. • Solve quadratic equations by factoring. • Solve quadratic equations using the quadratic formula. • Derive the quadratic formula by completing the square. (A.CED.3, A.REI.11, A.REI.12, A.REI.5, A.REI.6)

		• Write a system of linear equations in two variables to model a situation. • Determine if an ordered pair is a solution to a system and interpret the viability of solutions. • Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or non-viable options in a modeling context. • 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. • Solve a system of two equations or inequalities graphically, using tables, algebraically or with technology. • 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.

Unit 5: Quadratic Functions and Modeling

Domain-specific vocabulary: Pythagorean Theorem, proof, recursive formula, explicit formula

Illinois Learning Standards **Priority (70%)** **Supporting (20%)** **Additional (10%)**	Prerequisite Skills	Conceptual & Formative Understandings
8.G.6 Explain a proof of the Pythagorean Theorem and its converse. 8.G.7 Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions. Define and Use Zero and Negative Exponents 8.G.8 Apply the Pythagorean Theorem to find the distance between two points in a coordinate system. 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 linear and quadratic functions and show intercepts, maxima, and minima. c. Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior. F.IF.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. F.BF.4A 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, $f(x) = 2x^3$ or $f(x) = (x+1)/(x-1)$ for $x \neq 1$.* N.RN.3 Explain why the sum or product of two rational number 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. A.APR.3 Identify zeros of polynomials when suitable factorizations are available, and use the zeros to construct a rough graph of the function defined by the polynomial. *(The following standards are introduced in Unit 2 and 3)* *F.IF.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.★* *F.IF.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.★* *F.IF.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.★* *F.BF.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.* *F.BF.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.* *F.LE.3 Observe using graphs and tables that a quantity increasing exponentially eventually*	***Students should already be able to…*** (8.G.6, 8.G.7 and 8.G.8) • Use the properties of similarity, congruence, and right triangles. • Calculate square roots and squares. • Represent numbers in radical form (irrational) and to approximate these numbers as rational. • Evaluate linear equations in one variable with one solution using the real number system. • Use the properties of exponents and real numbers (commutative, associative, distributive, inverse, and identity). • Solve equations of the form $x^2 = p$ using the square root as the inverse operations of squaring. (A.SSE.1ab, A.REI.10, F.IF.3, F.IF.9, F.BF.2, F.LE.1ab, F.LE.2) • Solve one variable equations using the properties of equivalency. • Model real-world context with one- or two-variable equations. • Define a function and the parts of expressions, equations and functions. • Represent and interpret functions on a graph and in a table using scale and labels appropriately. • Write arithmetic sequences and linear functions and represent them in multiple ways. (F.IF.4, F.IF.5, F.IF.6, A.CED.1, F.BF.1ab, F.LE.3, F.LE.5, A.SSE.3abc) • Solve one-variable equations using the properties of equivalency. • Define a function and the different parts in expressions, equations and functions. • Represent linear and exponential functions on a graph or table and explain how scale and labels can change the look of a representation. (F.IF.6, F.IF.7abe, F.IF.8ab, F.IF.9, S.ID.6abc, A.SSE.3abc, F.BF.3, F.BF.1) • Solve one-variable equations and recognize equivalent forms. • Model real-world one-variable equations and two-variable equations limited to linear and exponential. • Define a function and distinguish between coefficients, factors and terms. • Recognize how functions can be represented on a graph and in a table and how scale and labels can modify the appearance of the representation. • Represent real-world situations with a linear or exponential model and make decisions about the appropriateness of each. • Represent data on a scatter plot both by hand and with technology. (N.RN.1, N.RN.2, N.RN.3, A.CED.1) • Apply the properties of integer exponents. • Recognize radical notation. • Recognize an irrational number. • Write rational numbers as terminating or repeating decimals. • Write irrational numbers as non-terminating, non-repeating decimals. • Solve linear equations.	**Conceptual Understandings:** ***Students will understand that . . .*** (8.G.6, 8.G.7 and 8.G.8) • Right triangles have a special relationship among the side lengths, which can be represented by a model and a formula. • The Pythagorean Theorem can be used to find the missing side lengths in a coordinate plane and real-world situations. • The Pythagorean Theorem and its converse can be proven. (A.SSE.1, A.REI.10, F.IF.3, F.IF.9, F.BF.2, F.LE.1ab, F.LE.2) • Arithmetic and geometric sequences both have a domain of the integers, but arithmetic sequences have equal intervals (common difference) and • geometric have equal factors (constant ratio). • Geometric sequences can be represented by both recursive and explicit formulas. • Exponential functions can be represented by a table, graph, and descriptions or in equation form. Each representation can be transferred to another • representation. • Discrete and continuous functions have properties that appear differently when graphed. • Exponential expressions represent a quantity in terms of its context. • Exponential expressions have equivalent forms that can reveal new information to aid in solving problems. (F.IF.4, F.IF.5, F.IF.6, A.CED.1, F.BF.1ab, F.LE.3, F.LE.5, A.SSE.3abc) • Exponential functions, like linear, can be used to model real-life situations. • Key features in graphs and tables shed light on relationships between two quantities. • Differences between linear and exponential functions, thus allowing them to use the appropriate model. • Units, scale, data displays, and levels of accuracy represented in situations. • Functions can be created to best-fit data represented on a scatter plot. (F.IF.6, F.IF.7abe, F.IF.8ab, F.IF.9, S.ID.6ab, A.SSE.3abc, F.BF.3, F.BF.1) • Quadratic functions have key features that can be represented on a graph and can be interpreted to provide information to describe relationships of two • quantities. These graphs can be compared to linear and exponential functions to model a situation. • The meaning of average rate of change of a quadratic model is interpreted based upon the context. • Quadratic expressions have equivalent forms that can reveal new information to aid in solving problems. • Data can be represented on and interpreted from a scatter plot. • Equations are affected by transformations of a graph and vice versa. (N.RN.1, N.RN.2, N.RN.3, A.CED.1) • Radical expressions can be written equivalently using rational exponents. • Properties of integer exponents may be applied to expressions with rational exponents.

exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function. *F.IF.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. (EOY)*	•	• Adding and multiplying two rational numbers results in a rational number. • The result of adding a rational number and an irrational number is an irrational number. • The result of multiplying a non-zero rational number to an irrational number is an irrational number. (A.SSE.2, A.CED.1, A.CED.2, A.REI.1, A.REI.2, F.IF.4, F.IF.6, F.IF.7abe, F.IF.9, A.REI.11, F.BF.3, F.BF.4a) • The degree of a polynomial helps to determine the end behavior of its graph • The zeroes of each factor of a polynomial determine the x-intercepts of its graph **Formative Understandings (Skills)** ***Students will be able to…*** • Explain a proof of the Pythagorean Theorem and its converse. (8.G.6) • Use the Pythagorean Theorem to solve for a missing side of a right triangle given the other 2 sides in both 2-D and 3-D problems. (8.G.7) • Apply the Pythagorean Theorem to solve problems in real-world contexts. (8.G.7) • Apply the Pythagorean Theorem to find the distance between two points in the coordinate system. (8.G.8) (A.SSE.1ab, A.REI.10, F.IF.3, F.IF.9, F.BF.2, F.LE.1abc, F.LE.2) • Write recursive and explicit equations for arithmetic and geometric functions. • Create tables or other representations given recursive or explicit equations for sequences. • Recognize patterns in exponential functions and geometric sequences. • Model situations using explicit and recursive equations. Translate among representations of exponential functions including tables, graphs, equations and real-life situations. • Distinguish between linear and exponential functions from multiple representations. (F.IF.4, F.IF.5, F.IF.6, A.CED.1, F.BF.1ab, F.LE.3, F.LE.5, A.SSE.3abc) • Translate between representations of exponential functions including tables, graphs, equations and real-life situations. • Distinguish between linear and exponential functions from multiple representations. • Rewrite exponential functions to reveal new information. • Use functions fitted to data to solve problems in the context of the data. • Interpret the parameters in a linear or exponential function in terms of a context. • Relate the domain of a function to its graph and, where applicable, to the quantitative relationship it describes. • 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. • Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity increasing linearly (F.IF.6, F.IF.7abe, F.IF.8ab, F.IF.9, S.ID.6ab, A.SSE.3abc, F.BF.3, F.BF.1ab) • Write a quadratic equation and/or function to model a real-life situation. • Use a model of a quadratic function to interpret information about a real-life situation. • Use and compare multiple representations of quadratic functions including tables, graphs, equations and real-life situations. • Distinguish between linear, exponential and quadratic functions from multiple representations. • Rewrite quadratic and exponential functions in different forms to reveal new

		information. • Estimate, calculate and interpret average rate of change over a specified interval. • Compare two functions represented in different ways (such as an equation compared to a table or graph). • Fit a linear, quadratic, or exponential model to data. • Assess the fit of a model to data by analyzing residuals and residual plots. • Transform graphs based on changes in equations and write equations based on a transformed parent graph. (N.RN.1, N.RN.2, N.RN.3, A.CED.1) • Apply the properties of exponents to algebraic expressions with integer exponents. • Apply the properties of exponents to algebraic expressions with rational exponents. • Write radical expressions as expressions with rational exponents. • Write expressions with rational exponents as radical expressions. • Write an exponential equation or inequality that models a given context. • Solve an exponential equation or inequality. • Interpret the solution of an equation or inequality in the context of the problem. (A.SSE.2, A.CED.1, A.CED.2, A.REI.1, A.REI.2, F.IF.4, F.IF.6, F.IF.7abe, F.IF.9, A.REI.11, F.BF.3, F.BF.4a) • Graph a polynomial given in factored form, indicating all intercepts and directions of end behaviors. • Use the structure of an expression to identify ways to rewrite it. • Create equations in one or two variables and use them to solve problems. • Construct viable arguments to justify a solution method. • Calculate and interpret the average rate of change of a function. • Identify the effect on the graph of replacing f(x) by f(x) + k, kf(x), f(kx) and f(x+k) • Use technology (graphs, tables) to solve the equation f(x) = g(x), where f(x) and/or g(x) are polynomial or rational functions. • Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions).

Unit 6: Descriptive Statistics

Domain-specific vocabulary: scatter plot, bivariate measurement data, clustering, outliers, positive or negative association, linear association, nonlinear association, frequency, dot plots, histogram, box plots, data distribution, median, mean, mode, interquartile range, standard deviation, frequency tables, frequencies: joint, marginal, conditional relative; line of best fit, correlation, causation

Illinois Learning Standards Priority (70%) Supporting (20%) Additional (10%)	Prerequisite Skills	Conceptual & Formative Understandings
8.SP.1 Construct and interpret scatter plots for bivariate measurement data to investigate patterns of association between two quantities. Describe patterns such as clustering, outliers, positive or negative association, linear association, and nonlinear association. *(EOY)* 8.SP.2 Know that straight lines are widely used to model relationships between two quantitative variables. For scatter plots that suggest a linear association, informally fit a straight line, and informally assess the model fit by judging the closeness of the data points to the line. 8.SP.3 Use the equation of a linear model to solve problems in the context of bivariate measurement data, interpreting the slope and intercept. *For example, in a linear model for a biology experiment, interpret a slope of 1.5 cm/hr as meaning that an additional hour of sunlight each day is associated with an additional 1.5 cm in mature plant height.* 8.SP.4 Understand that patterns of association can also be seen in bivariate categorical data by displaying frequencies and relative frequencies in a two-way table. Construct and interpret a two-way table summarizing data on two categorical variables collected from the same subjects. Use relative frequencies calculated for rows or columns to describe possible association between the two variables. For example, collect data from students in your class on whether or not they have a curfew on school nights and whether or not they have assigned chores at home. Is there evidence that those who have a curfew also tend to have chores? (EOY) S-ID.1 Represent data with plots on the real number line (dot plots, histograms, and box plots).★ S-ID.2 Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.★ S-ID.3 Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).★ S-ID.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.★ S-ID.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. S-ID.7 Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data.★ S-ID.8 Compute (using technology) and interpret the correlation coefficient of a linear fit.★ S-ID.9 Distinguish between correlation and causation.★ (All S.ID standards are EOY.)	***Students should already be able to…*** (8.SP.1-4) • Use the coordinate plane. (S.ID.1-9)not 4 • Construct and interpret scatter plots for bivariate measurement data to investigate patterns of association between two quantities. • Describe patterns such as clustering, outliers, positive or negative association, linear association, and nonlinear association. • Know that straight lines are widely used to model relationships between two quantitative variables. For scatter plots that suggest a linear association, informally fit a straight line, and informally assess the model fit by judging the closeness of the data points to the line. • Understand that patterns of association can also be seen in bivariate categorical data by displaying frequencies and relative frequencies in a two-way table. Construct and interpret a two-way table summarizing data on two categorical variables collected from the same subjects. Use relative frequencies calculated for rows or columns to describe possible association between the two variables.	**Conceptual Understandings:** ***Students will understand that . . .*** (8.SP.1-4) • Written descriptions, tables, graphs, and equations are useful in representing and investigating relationships between varying quantities. • Different representations (written descriptions, tables, graphs, and equations) of the relationships between varying quantities may have different strengths and weaknesses. • Linear functions may be used to represent and generalize real situations. • Slope and y-intercept are keys to solving real problems involving linear relationship models of data. • Some data may be misleading based on representation. (S.ID.1-9)not 4 • Data can be represented and interpreted in a variety of formats. • Extreme data points (outliers) can skew interpretations of a set of data. • Synthesizing information from multiple sets of data results in evidence-based interpretation. • Center and spread of a data set may be compared in multiple ways. • Data in a two –way frequency table can be summarized using relative frequencies in the context of the data. • A line of best fit can be generated for a set of data to model the relationship between two variables by hand or with technology. • A line of best fit aims to minimize the vertical distances between the data points and the points on the line and may be used to make predictions within • the proximity of the data. • Making predictions for values within or near the data set is more reliable than for values far beyond the data set. • Correlation does not imply causation. **Formative Understandings (Skills)** ***Students will be able to…*** • Construct and interpret scatter plots and two-way tables for patterns such as positive or negative association, linearity or curvature, and outliers. (8.SP.1) • Generate an approximate line of best fit. (8.SP.2) • Use the equation of a linear model to solve problems in the context of bivariate measurement data. (8.SP.3) • Interpret the slope and y-intercept of the line of best fit in context. (8.SP.3) • Show that patterns of association can also be seen in bivariate categorical data by displaying frequencies and relative frequencies in a two-way table. (8.SP.4) • Construct and interpret a two-way table summarizing data on two categorical variables collected from the same subjects. (8.SP.4) • Use relative frequencies calculated for rows or columns to describe possible association between the two variables. (8.SP.4) (S.ID.1-9) not 4

		• Use and convert (as necessary) the appropriate unit when solving a multi=step real-world problem • Interpret units used in formulas and real-world problems • Choose a level of accuracy appropriate to limitations on measurement when reporting quantities • Choose and interpret the scale and origin in graphs and data displays • define the appropriate quantities to describe the characteristics of interest for a population • Determine and interpret the appropriate quantities when communicating and using visual representations • Define variables in the context of a situation. • Use and justify units to evaluate the appropriateness of a solution • Use correct numerical value based on context and tools used in measurement. • Represent data visually in scatter plots, histograms, or box plots. • Compute the measures of central tendencies of a data set (mean, median, and mode). • Compute the range, max/min, quartiles and standard deviation of multiple data sets. • Compare measures of center (mean, median) and spread (range, maximum, minimum, quartiles) from multiple data sets. • Identify and describe possible outliers in a data set. • Use measures of central tendencies, range, max/min, quartiles, and standard deviation to interpret differences between data sets. • Create two-way frequency tables for categorical data. • Identify joint, marginal, and conditional relative frequencies within two-way tables. • Interpret relative frequencies in the context of the data. • Recognized possible associations and trends in data represented in two-way tables. • Create a scatter plot of data, including axes labels and appropriate ranges and scales, both by hand and with technology. • Estimate the rate of change over a specified interval from a scatter plot. • Interpret the slope and y-intercept of a best-fit line in the context of the data. • Interpret the meaning of the correlation coefficient for a line of best fit.