CARNEGIE LEARNING

1 Exploring Patterns in Linear and Quadratic Relationships

MATHia Unit	MATHia Workspace	Overview		Concept Builder	Mastery	Strategies: Animations	Classifications	Explore Tools	Graphing Tools	Interactive Diagrams	Interactive Worksheets	Proof	Real-World Scenarios	Solvers	Worked Example
Topic 1: Extending Linear Relationships															
Graphing Linear Inequalities in Two Variables	Exploring Linear Inequalities	Students model solution sets of inequalities in two variables as half-planes on the coordinate plane. They are introduced to cases where a point is included and excluded from the solution set of an inequality. Students connect graphical solutions with algebraic solutions.	2A.3F	✔											
	Graphing Linear Inequalities in Two Variables	Students graph and solve linear inequalities in two variables graphically by determining the correct half-planes for the solution sets.	2A.3F 2A.3G		✔							•			
	Systems of Linear Inequalities	Students determine the intersections between two inequalities, graph the inequalities, and shade the regions representing the solutions and their intersections.	2A.3F 2A.3G		✔							•			
	Interpreting Solutions to Systems of Inequalities	Students will learn how to interpret solutions to systems of inequalities.	2A.3E	✔							•				
Defining Absolute Value Functions and Transformations	Building Absolute Value Functions	Students watch an animation showing how taking the absolute value of a number reflects that number across 0, or across the x-axis. Students use reflections to create the basic absolute value function from the functions f(x) = x and f(x) = -x. They show that the two functions f(x) = |x| and f(x) = |-x| are equivalent.	2A.2A 2A.6C	✔						•				•	
	Vertically Dilating Absolute Value Functions	Students vertically dilate graphs of absolute value functions. They use verbal descriptions, graphs, and algebraic representations.	2A.6C		✔										
	Vertically Translating Absolute Value Functions	Students vertically shift graphs of absolute value functions. They use verbal descriptions, graphs, and algebraic representations.	2A.6C		✔										
	Horizontally Translating Absolute Value Functions	Students horizontally shift graphs of absolute value functions. They use verbal descriptions, graphs, and algebraic representations.	2A.6C		✔										

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Defining Absolute Value Functions and Transformations (continued)	Multiple Transformations of Absolute Value Functions	Given a representation of a transformed function, students determine how the basic absolute value function was transformed to create the new function.	2A.6C		✔										
Absolute Value Equations and Inequalities	Reasoning About Absolute Value Functions	Students determine the solutions to absolute value equations by graphing each side of the equation as a separate function and looking for the points of intersection. They determine if an absolute value equation has 0, 1, or 2 solutions. They use a graph to solve a real-world problem modeled by an absolute value function.	2A.6E	✔											
	Graphing Simple Absolute Value Equations Using Number Lines	Students write a simple absolute value equation from a verbal statement, determine the number of solutions, and then represent the solution on a number line.	2A.6E		✔							•			
	Introduction to Absolute Value Equations	Students practice rewriting absolute value equations as two linear equations. They solve absolute value equations algebraically using properties of equality. Students sort absolute value equations by their number of solutions. They use absolute value equations to solve a contextual problem and consider the reasonableness of the solutions.	2A.6E	✔							•				
	Solving Absolute Value Equations	Students solve multi-step absolute value equations, determine the number of solutions, and then represent the solution on a number line	2A.6E		✔							•			
	Reasoning About Absolute Value Inequalities	Students use graphical representations to solve absolute value inequalities. They learn to write equivalent compound inequalities for absolute value inequalities.	2A.6F	✔							•				

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Topic 2 Exploring and Analyzing Patterns															
Observing Patterns	Exploring and Analyzing Patterns	Students watch a video about a well-known mathematician creating an expression for the sum of a sequence of numbers from a pattern he noticed and then answer questions that move them from a numerical expression to an algebraic one. Next, students analyze three different patterns to generate linear, exponential, and quadratic algebraic expressions.	A.12C 2A.8A	✔		•									
	Comparing Familiar Function Representations	Students review three familiar function families--linear, quadratic, and exponential. They practice matching the equation of a function and the graph of a function to one of these function families. Finally, the choose which of these function families represents the relationship given in the context of a real-world problem.	A.2C A.6C A.9C	✔						•					
	Identifying Key Characteristics of Graphs of Functions	Students will identify key characteristics from the graph of a function, such as the intercepts, minimum and maximum x-values, minimum and maximum y-values, domain, and range.	A.3C A.7A A.9D 2A.2A		✔							•			
Forms of Quadratic Functions	Examining the Shape and Structure of Quadratic Functions	Students sort functions based upon whether they are written in standard, factored or vertex form. They deal with each form independently, where they are guided as to how to identify key characteristics of the graph from the function. They identify the concavity and y-intercept from functions in standard form, the concavity and x-intercepts from functions in factored form, and the concavity, vertex, and axis of symmetry from functions in vertex form. Given graphs, they use key characteristics to select the function that generates the graph.	A.6B A.7A	✔						•					

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Forms of Quadratic Functions (continued)	Quadratic Modeling	Students complete a table of values and graph from a scenario represented by a quadratic model. Students construct the quadratic function for the scenario as a product of a monomial and a binomial, or as the product of two binomials.	2A.4B		✔							•		•	
Solving Quadratic Equations Using Multiple Strategies	Solving Quadratic Equations by Factoring	Students solve quadratic equations by factoring and applying the zero-product property.	2A.4F		✔										
	Completing the Square	Students analyze a worked example of a quadratic function in general form being written in vertex form through the process of completing the square. They then practice completing the square using polynomials and area models before filling in unknown values in trinomials that create perfect square trinomials. Finally, students are shown the algebraic method of changing a quadratic function in general form to vertex form by completing the square. They use the algebra shown to determine the axis of symmetry and vertex of quadratic functions in general form.	2A.4D	✔											
	Problem Solving Using Completing the Square	Students use the method of Completing the Square to convert quadratic equations to vertex form in order to solve real-world problems in different situations by revealing maxima of quadratic functions.	2A.4D	✔											
	Quadratic Equation Solving	Students solve quadratic equations by using factoring or the quadratic formula.	2A.4F		✔										
Imaginary and Complex Numbers	Introduction to Complex Numbers	Students watch a video introducing them to the imaginary number line and its relation to the real number line. They then practice identifying real and imaginary numbers through the sorting tool. Finally, students are introduced to complex numbers and practice identifying them on the complex plane to help them understand that all numbers are complex, but some are real and some are purely imaginary.	2A.7A	✔		•				•			•		

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Imaginary and Complex Numbers (continued)	Rewriting Radicals with Negative Radicands	Students simplify radical expressions that result in complex numbers.	2A.7G		✔										
	Rewriting Powers of *i*	Students identify expressions that are equivalent to i, -1, -i, and 1. They use the definition of i to rewrite higher powers of i.	2A.7A	✔						•				•	
	Adding and Subtracting Complex Numbers	Students add and subtract complex numbers.	2A.7A		✔										
	Multiplying Complex Numbers	Students multiply complex numbers, including both problems where the two complex numbers are complex conjugates, and problems where they are not.	2A.7A		✔										
	Solving Quadratic Equations with Complex Roots	Students solve quadratic equations, some of which have real solutions and some of which have complex solutions.	2A.4F		✔										

Topic 3 Applications of Quadratics															
Using Quadratic Functions to Model Data	Using Quadratic Models	Students use equations of quadratic regression models, the solver, and graphs to answer questions.	2A.8B 2A.8C		✔							•		•	
	Introduction to Inverses	Students watch an animation that shows the graph of the inverse of a function is a reflection of the function across the line y = x. They determine whether a function is a one-to-one function given its graph and the graph of its inverse. Students identify the graph of the inverse of a function by considering its reflection across y = x. They complete a table of values for the inverse of a function and determine its graph.	2A.2B	✔						•	•				
	Recognizing Graphs of Inverses	Given the graphs of two relations, students decide if the relations are inverses.	2A.2B		✔										

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2 Analyzing Structure

MATHia Unit	MATHia Workspace	Overview		Concept Builder	Mastery	Strategies: Animations	Classifications	Explore Tools	Graphing Tools	Interactive Diagrams	Interactive Worksheets	Proof	Real-World Scenarios	Solvers	Worked Example
Topic 1: Composing and Decomposing Functions															
Reviewing Function Transformations	Transforming Functions	Students use interactive Explore Tools to investigate transformations of linear, exponential, and quadratic functions, including horizontal and vertical translations and dilations. Students use the Explore Tools to solve real-world problems modeling changes to an exponential function describing doubling and to a quadratic function describing the height of a jump. In the final problems, students identify the graphs of transformations of quadratic functions based on their transformation equations.	2A.5A A.3E A.7C	✔							•	•		•	
	Quadratic Transformations	Given a representation of a transformed function, students determine how the basic quadratic function was transformed to create the new function.	A.7C		✔							•			
Exploring Cubic Functions	Modeling Polynomial Functions	Students solve two problems in context involving polynomial, specifically, cubic functions. The first half of each problem requires students to use the function to solve for the dependent variable. The second half of the problem requires students to use the graph to solve for the independent variable and an interpret a minimum or maximum point on the graph.	2A.2A	✔										•	
Topic 2: Characteristics of Polynomial Functions															
Power Functions	Analyzing Polynomial Functions	Students explore power functions, concentrating on cubics and quartics and the key characteristics of end behavior and extrema. The determine end behavior based upon whether the functions are even-degree or odd-degree and the sign of its leading term. They use graphs to determine extrema, relative maximum and minimums, and absolute maximums and minimums.	2A.2A	✔						•		•			

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2	Analyzing Structure					Strategies									
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Power Functions (continued)	Classifying Polynomial Functions	Students classify graphs of polynomial functions by their key characteristics.	2A.2A		✔										
Key Characteristics of Polynomial Functions	Identifying Key Characteristics of Polynomial Functions	Students identify key characteristics from the graphs of polynomial functions.	2A.2A		✔							•			
	Identifying Zeros of Polynomials	Students are introduced to the term zeros, with clarification made among real zeros, imaginary zeros and zeros with multiplicity. They identify the number and types of zeros when given graphs of cubic and quartic functions. They sort graphs based upon their number of real zeros. When given graphs, they select the function that represents the graph based upon whether it is an even-degree or odd-degree function with an a-value that is positive or negative; in one case, differentiation between the number of zeros is also required.	2A.7D	✔						•		•			
	Using Zeros to Sketch Graphs of Polynomial Functions	Sketch a third- or fourth-order polynomial function.	2A.2A 2A.7D		✔							•			
Analyzing Polynomial Functions	Interpreting Key Features of Graphs in Terms of Quantities	Students are provided graphs in context. They interpret the meaning of relative maximum and minimum points, y-intercepts, x-intercepts, and increasing and decreasing intervals.	2A.2A	✔								•		•	

3 Developing Structural Similarities

MATHia Unit	MATHia Workspace	Overview		Concept Builder	Mastery	Strategies: Animations	Classifications	Explore Tools	Graphing Tools	Interactive Diagrams	Interactive Worksheets	Proof	Real-World Scenarios	Solvers	Worked Example
Topic 1: Relating Factors and Zeros															
Polynomial Multiplication and Division	Using a Factor Table to Multiply Polynomials	Students use factor tables to multiply polynomials. Students combine like terms.	2A.7B		✔									•	
	Multiplying Polynomials	Students determine which factor table is apprpriate for a given problem, set up the table, and then use the table to multiply polynomials.	2A.7B		✔									•	
	Synthetic Division	Students use synthetic division as an efficient method to divide a higher-order polynomial by a linear divisor.	2A.7C		✔										
	Factoring Higher-Order Polynomials	Students factor quadratic expressions using all known factoring methods.	2A.7D 2A.7E		✔										
	Solving Polynomial Functions	For the first time, students see the algebraic representations that determine the graphs of polynomial functions. They make a connection between f(x) = 0 and a polynomial equation set equal to zero. They begin to solve polynomial equations by seeing both graphical and algebraic method(using factored form) for the same equation. Students then focus on cubic equations with multiple or imaginary roots, once again connecting graphical and algebraic solution methods. Next, they deal with cubic equations that are not originally set equal to zero, are not in factored form or require the use of the quadratic formula to determine some roots. Students then practice solving quartic equations using these same skills.	2A.6B	✔											

4 Extending Beyond Polynomials

MATHia Unit	MATHia Workspace	Overview		Concept Builder	Mastery	Strategies: Animations	Classifications	Explore Tools	Graphing Tools	Interactive Diagrams	Interactive Worksheets	Proof	Real-World Scenarios	Solvers	Worked Example
Topic 1: Rational Functions															
Introduction to Rational Functions	Introduction to Rational Functions	Students are given the definition of a rational function and use the definition to sort given functions as rational functions or not. They are then shown the graph of a rational function and introduced to horizontal and vertical asymptotes. Students use a function and its graph to describe the asymptotes. Next they determine asymptotes of rational functions using only the equation.	2A.6G 2A.6K	✔						•					
	Modeling Rational Functions	Students solve rational equation problems using a worksheet format, with separate columns for the independent quantity, the numerator, the denominator, and the rational expressions. All questions have the independent quantity given.	2A.6H		✔									•	
	Rewriting Rational Expressions	Students simplify simple rational expressions.	2A.7F		✔										
Operations with Rational Expressions	Adding and Subtracting Rational Expressions	Students simplify sums and differences of rational expressions.	2A.7F		✔										
	Multiplying and Dividing Rational Expressions	Students simplify products and quotients of rational expressions.	2A.7F		✔										
Solving Problems with Rational Equations	Solving Rational Equations that Result in Linear Equations	Students solve rational equations, and classify the solutions as valid or extraneous.	2A.6I		✔										
Solving Work, Mixture, Distance, and Cost Problems	Modeling Ratios as Rational Functions	Students solve rational equation problems using a worksheet format, with separate columns for the independent quantity, the numerator, the denominator, and the rational expressions. Questions have either the independent quantity or a dependent quantity given, with the Solver available to solve for independent quantities.	2A.6H 2A.6I		✔									•	

4	Extending Beyond Polynomials					Strategies									
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Solving Work, Mixture, Distance, and Cost Problems (continued)	Using Rational Models	Students solve contextual rational equation problems using a given equation. Questions have either the independent quantity or the dependent quantity given, with the Solver available to solve for independent quantities.	2A.6H 2A.7F		✔									•	
	Solving Work, Mixture, and Distance Problems	Introduction to solving work, mixture, and distance problems using a worksheet format. Students either write expressions for given problem entity descriptions, or select problem entity descriptions for given expressions. As students complete steps, the associated expressions are echoed in the worksheet. Students conclude by equating two expressions for the same entity which are used to solve for an unknown.	2A.6H 2A.6I		✔									•	
	Modeling and Solving with Rational Functions	Students solve work, mixture, and distance problems using a worksheet format. They write expressions for the given information, then use relationships with related problem entities to write expressions for them, and conclude by solving for an unknown by equating two expressions for the same entity.	2A.6H 2A.6I		✔									•	
Topic 2: Radical Functions															
Inverses of Functions	Investigating Inverses of Functions	Students watch an animation which demonstrates that the inverse of a point is formed by reversing the x- and y-coordinates of a point. Thus, the inverse of a function, the set of all x-y coordinates which satisfy an equation, is a reflection of the original function across the line y = x. Students use the Horizontal Line Test to identify the graphs of inverses of functions, and determine whether a function is invertible.	2A.2A	✔		•						•			
	Sketching Graphs of Inverses	Students enter the inverse coordinate pairs, plot them on a graph, and reason about the domain and range.	2A.2B		✔							•		•	

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Inverses of Functions (continued)	Graphing Square Root Functions	Students learn how to determine and graph the square root function as the inverse of the quadratic function $y = x^2$ with a domain restricted to x >= 0. Students identify simple graphed transformations of the square root function and write equations for those transformations.	2A.2A 2A.2C 2A.4B	✔								•			
	Calculating Inverses of Linear Functions	Given a function, students determine the equation of the inverse function and use composition of function to verify that the functions are inverses.	2A.2B 2A.2D		✔										
Composition of Functions	Modeling with Linear Function Composition	Given a scenario that can be modeled by a composition of functions, students determine and use a function.	2A.2D		✔										
	Composing Linear Functions	Given two functions in function notation, students determine and use the two related compositions of functions.	2A.2D		✔										
Rewriting Radical Expressions	Rewriting Radicals	Students simplify numerical radical expressions.	2A.7G		✔										
	Adding and Subtracting Radicals	Students simplify and add and subtract numerical radical expressions.	2A.7G		✔										
	Multiplying Radicals	Students multiply and simplify numerical radical expressions.	2A.7G		✔										
	Dividing Radicals	Students divide and simplify numerical radical expressions.	2A.7G		✔										
	Rewriting Radicals with Variables	Students simplify radical expressions with variables.	2A.7G		✔										
	Adding and Subtracting Radicals with Variables	Students simplify and add and subtract radical expressions with variables.	2A.7G		✔										

5	Inverting Functions					Strategies									
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Topic 1: Exponential and Logarithmic Functions															
Using Exponential and Logarithmic Functions	Properties of Exponential Graphs	Students recall exponential functions and identify exponential growth and decay functions by their equation forms. Students watch an animation demonstrating how to build an exponential expression modeling an account balance earning compound interest. They use the formula $A = P(1 + r)^t$ to determine compound interest amounts. Students then learn that the constant e represents the base of an exponential when the interest is compounded continuously. Students solve real-world problems about changes in populations using the formula for continuous exponential growth or decay.	2A.5A 2A.5D	✔		•									
	Introduction to Logarithmic Functions	Students watch an animation demonstrating that a logarithm is an expression equal to the exponent of a corresponding exponential expression and that a logarithmic function is the inverse of the corresponding exponential function. Students evaluate logarithms and generalize about forms such as log_a(a), log_a(1), and log_a(1/a). Students identify and analyze logarithmic functions of base 2, 10, and e, the natural logarithm.	2A.5B 2A.5C	✔		•						•			
	Exploring Exponential Regression	Students use an interactive Explore Tool to investigate exponential regression functions. They enter data related to various real-world contexts and use the Explore Tool to determine the exponential regression equation. Students interpret the parameters of the regression equation in the context of the data and investigate how moving the points of the data set affects those parameters. They use a regression equation to make predictions based on interpolation and extrapolation, determining which prediction is more accurate and why.	2A.8B 2A.8C	✔		•									

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5	Inverting Functions					Strategies									
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Topic 2: Exponential and Logarithmic Equations															
Solve Logarithmic Equations	Solving Base 2 and Base 10 Equations	Students solve equations of the form $A*B^x = C$ and $A*\log_B(x) = C$, where B is either 2 or 10.	2A.5C 2A.5D		✔										
	Solving Base *e* Equations	Students solve equations of the form $A*e^x = C$ and $A*\ln(x) = C$.	2A.5C 2A.5D		✔										