Educational Epiphany ™

Districtwide PLC Protocol for **Mathematics**

Teacher/Teacher Team:
Grade/Course: Algebra 2
Date: Week of September 26, 2022

#	Planning Question	Teacher/Teacher Team Response	
	Algebra 2 Coherence Tool: Access the foundational standards to make connections to previously taught skills during the lesson introduction.		
1	Which **state standard** is your lesson progression addressing?	**Lesson 3.1 – Graphing Polynomial Functions**	**Lesson 3.2 – Adding, Subtracting, and Multiplying Polynomials**
		A2.F.IF.A.1 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. ★ **Foundational Standards:** A1.F.IF.A.1, A1.N.Q.A.1 **A2.F.IF.A.2** 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.★ **Foundational Standard:** A1.F.IF.A.2 **A2.F.IF.B.3** Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology. ★ **b.** Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior. **Foundational Standards:** None	**A2.F.IF.B.5** Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). **Foundational Standard:** A1.F.IF.C.7a **A2.F.BF.A.1** Write a function that describes a relationship between two quantities.★ **b.** Combine standard function types using arithmetic operations. **Foundational Standards:** None
2	What **mathematical concepts** are embedded in the state standard?	**Understand that:** • A polynomial function is a function whose rule is either a monomial or a sum of monomials. • The key features of the graph of a polynomial function – such as its end behavior, intercepts, and turning points – can be used to sketch a graph of the function. • Students describe turning points and relative minimum and maximum values of the graphs of polynomial functions. • Students understand that when the leading coefficient is positive, the graph increases as x approaches infinity. When the leading coefficient is negative the graph decreases as x approaches infinity. They recognize that for even functions the end behavior of the graph is the same as x approaches positive and negative	**Understand that:** • Just as with real numbers, the properties of operations can be used to add, subtract, and multiply polynomials. Polynomial functions can be used to represent and compare real-world situations. • Students apply what they know about the Commutative Property, the Associative Property, and the combining like terms to add and subtract polynomials. They apply the Distributive Property to multiply polynomials. • Students consider whether the set of polynomials is closed under addition and subtraction and use this to connect properties of the set of real numbers to the set of polynomials.

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		infinity, and for odd functions the end behavior of the graph is different as x approaches positive and negative infinity.	
3	What teacher **knowledge, reminders, and misconceptions** are assumed in the standard?	**Knowledge:** • The lesson emphasizes a blend of conceptual understanding and application. • Students understand that the leading coefficient and the degree of a polynomial can be used to predict the end behavior of a function. • Students graph polynomials and interpret the key features to solve problems that involve predicting the behavior of the function that the graph represents. • Students use tools strategically when they use technology to make tables of values and explore the graphs of polynomial functions. • Students use the structure of a polynomial equation, including the sign of the leading coefficient and the degree of the polynomial, to predict the end behavior of the graph of the function. • Students graph and identify the key features of a polynomial function. • Students use the leading coefficient and degree of the polynomial function to predict the end behavior of its graph. **Reminders and Misconceptions:** • Students identified the key features of quadratic functions. • Students may incorrectly define the greatest coefficient as the leading coefficient. Remind students to rewrite the polynomial, reordering the terms so the exponents are in descending order. • Students may not remember that, when moving and reordering a polynomial, the sign belongs to the term and must be moved also. Have students rewrite the polynomial so all terms are added together before reordering.	**Knowledge:** • This lesson emphasizes a blend of conceptual understanding and procedural skill and fluency. • Students understand that polynomials are closed under the operations of addition, subtraction, and multiplication. • Students use efficient strategies and the properties of operations to add, subtract, and multiply polynomials. • Students deconceptualize real-world problems, such as those about changes made to the specifications of manufactured products by writing equations to represent the problems. Then, after manipulating the symbols, they contextualize the answers. • Students develop logical arguments to show whether the set of polynomials is closed under the operations of addition, subtraction, multiplication, and division. • Students add, subtract, and multiply polynomials. • Students compare properties of polynomial functions represented in different ways. **Reminders and Misconceptions:** • Students graphed, classified, and interpreted the key features of a polynomial function.
4	What **objective(s)** must be taught? In what order? Why?	**PBO:** • SWBAT graph the following functions, identify key features of the graph, and interpret the meaning of the key features in relationship to the context of the problem IOT solve a real-world problem. (square root function, cube root function, exponential function, polynomial function, logarithmic function) **(A2.F.IF.A.1)** • SWBAT calculate and interpret the average rate of change when given an equation or table of a polynomial, exponential, or logarithmic function IOT understand the meaning in a contextual problem. **(A2.F.IF.A.2)**	**PBO:** • SWBAT rewrite expressions IOT represent the expressions in different forms. **(A2.A.SSE.A.1)** • SWBAT compare properties of two exponential, two logarithmic, two polynomial functions or two functions from different function families each represented in a different way (algebraically, graphically, numerically in tables, or verbally) IOT explain the relationships of the various representations of the functions. **(A2.F.IF.B.5)**

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		• SWBAT estimate the average rate of change over a specified interval of a polynomial, exponential, or logarithmic function when given a graph IOT understand the meaning in a contextual problem. **(A2.F.IF.A.2)** • SWBAT describe end behavior of a polynomial function with degree greater than two given in standard form and factored form IOT explain the relationship that exists between a contextual problem and the key features of a graph. **(A2.F.IF.B.3b)** • SWBAT compare properties of two exponential, two logarithmic, two polynomial functions or two functions from different function families each represented in a different way (algebraically, graphically, numerically in tables, or verbally) IOT explain the relationships of the various representations of the functions. **(A2.F.IF.B.5)** **Lesson objectives**: • Graph polynomial functions and show the key features of the graph. • Predict the end behavior of polynomial functions by interpreting the leading coefficients and degrees. • Sketch graphs showing key features, given a verbal description.	• SWBAT combine functions using arithmetic operations IOT generate a function that describes a real-world situation. **(A2.F.BF.A.1b)** **Lesson objectives**: • Add, subtract, and multiply polynomials and understand that polynomials are closed under these operations. • Compare a polynomial function represented algebraically with one represented graphically.
5	What **academic language** must be taught before the teacher models for students? How will the academic language be **taught and assessed**?	**Academic Language:** • **algebraic -** relating to, involving, or according to the laws of algebra • **average rate of change** – the slope of a line or curve on a given range • **calculate -** to determine the amount or number of something mathematically • **compare** – to note similarities ; to note the similarities or dissimilarities between events, actions, or components • **context** – a situation used to describe a mathematical problem • **cube root** – one of three identical factors of a number that is the product of those factors • **degree (of polynomial) - t**he highest power of unknowns or variables present in a polynomial • **describe** – give an account in words of (someone or something) that includes all the relevant characteristics • **end behavior** – the behavior of the graph of f(x) as x approaches positive infinity or negative infinity. • **equation** – a mathematical statement containing an equal sign to show that two expressions are equal • **estimate** – an approximate calculation; judgment of the value, number, quantity, or extent of something • **explain** – make clear by describing; to make something clear by describing it in more detail or by revealing relevant facts or ideas	**Academic Language:** • **algebraic -** relating to, involving, or according to the laws of algebra • **arithmetic -** refers to the use of addition, subtraction, multiplication, or division • **Associate Property -** the property that states that when adding three or more real numbers, the sum is always the same regardless of their grouping • **combine** – unite; merge • **Commutative Property** - tis property means that addends can be added in any order and the sum is always the same. • **compare** – to note similarities ; to note the similarities or dissimilarities between events, actions, or components • **Distributive Property** - an operation that is independent of being carried out before or after another operation • **explain** – make clear by describing; to make something clear by describing it in more detail or by revealing relevant facts or ideas • **exponential function –** A nonlinear function in which the independent value is an exponent in the equation, and can be written in the following forms; $y = ab^x$, $y = a(1+r)^x$, or $y = a(1 - r)^x$ • **expression** – a group of mathematical numbers and/or symbols representing a number or quantity • **form** – the visible shape or configuration of something

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		• **exponential function –** nonlinear function in which the independent value is an exponent in the equation, and can be written in the following forms; $y = ab^x$, $y = a(1+r)^x$, or $y = a(1 – r)^x$ • **factored Form** - rewriting the polynomial in order to determine the zeros or x-intercepts of the function • **function** – a relation in which every domain(input) value is paired with exactly one range(output) value. • **graph** – a pictorial diagram used to show a numerical relationship using distinctive plots. lines, bars, etc.; to plot • **identify** – to recognize and name; to make sense of and assign meaning to the data • **interpret** – explain the meaning of (information, words, action) • **key features** – Intercepts; interval where the function is increasing, decreasing, positive, or negative; relative maximums and minimums; symmetries; end behavior; domain; as determined by the function or by context. • **leading coefficient -** the non-zero term that is multiplied by the greatest power of x is the leading coefficient • **Logarithmic function** – a quantity representing the power to which a fixed number (the base) must be raised to produce a given number; the inverse of an exponential function • **numeric -** of, related to or expressed as a number or numbers • **polynomial function** – a function of more than two algebraic terms, especially the sum of several terms that contain different powers of the same variable(s) • **polynomial function** – An expression of more than two algebraic terms, especially the sum of several terms that contain different powers of the same variable(s). • **problem** – a question that needs a solution • **property** – a mathematical rule; a character or attribute that something has • **real-world** – related to a concrete setting • **relationship** – connection between two or more things; the way in which two or more concepts are connected • **relationship** – the way in which two or more concepts are connected • **relative maximum -** the value of the function at an up-to-down turning point • **relative minimum -** the value of the function at a down-to-up turning point • **represent** – state or point something out • **solve** – to find an answer	• **function** – a relation in which every domain(input) value is paired with exactly one range(output) value • **graph** – a diagram showing the relation between variable quantities • **logarithmic function** – a quantity representing the power to which a fixed number (the base) must be raised to produce a given number • **numeric -** of, related to or expressed as a number or numbers • **polynomial function** – An expression of more than two algebraic terms, especially the sum of several terms that contain different powers of the same variable(s). • **property** – a mathematical rule; a character or attribute that something has • **real-world** – relating to a concrete setting • **relationship** – the way in which two or more concepts are connected • **represent** – state or point something out • **rewrite -**to revise words, symbols, equations, expressions, etc. in a different way • **situation -** a set of circumstances in which one finds oneself; a state of affairs • **table** – numbers or quantities arranged in rows and columns • **verbal -** relating to, or consisting of words; spoken words rather than written or typed **Instructional Practice 2:** Strategies used to teach unfamiliar words will include: • 30 – 30 – 30 (common math-related word parts in the text, problem, or objective) • Point of Use Annotation of the Performance-Based Objective • Universal Language of Literacy • Word and Definition Walls • Word Parts • Context Clues • Point of Use Annotation of the Text (in Real-Time)

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		• **square root** – one of two identical factors of a number that is the product of those factors • **Standard Form of a Polynomial** - to express a polynomial by putting the terms in descending exponent order • **table** – numbers or quantities arranged in rows and columns • turning point - of the graph of a function is a point where the graph changes direction from upwards to downwards or from downwards to upwards • **understand** – comprehend; grasp the intended meaning of; infer something from information received • **verbal -** relating to, or consisting of words; spoken words rather than written or typed **Instructional Practice 2:** Strategies used to teach unfamiliar words will include: • 30 – 30 – 30 (common math-related word parts in the text, problem, or objective) • Point of Use Annotation of the Performance-Based Objective • Universal Language of Literacy • Word and Definition Walls • Word Parts • Context Clues • Point of Use Annotation of the Text (in Real-Time)	
6	What **practice problems** are you planning to use for the I Do, We Do, You Do in Pairs and You Do Without Assistance? What did you learn from working the problems **in advance** of using them in class with students?	**Station Rotation Model Suggestions** **Teacher-Led Station:** Teachers can work with students on additional We Do problems. • Additional Examples – TE pg. 131, pg. 132, pg. 134 • 3-1 Reteach to Build Understanding **Online Station**: Students can watch and engage with Virtual Nerd Video lessons. Students will initially tell what they think the answer to the question is or their opinion regarding an issue, and/or their thoughts based on a prompt. Then the students will watch the video to decide as to whether their original assertion was accurate, justified, etc. • 3-1: Virtual Nerd™: How Do You Use a Table to Estimate Where the Turning Points of a Polynomial Function Occur? • 3-1: Virtual Nerd™: How Do You Sketch the Graph of a Polynomial Function Given Characteristics of the Graph? **Offline Station:** Students would complete problems and exercises selected for the You Do in Pairs part of the lesson. • Lesson Performance Task #32 – Pg. 138 • 3-1 Additional Practice • 3-1 Mathematical Literacy and Vocabulary • 3-1 Enrichment	**Station Rotation Model Suggestions** **Teacher-Led Station:** Teachers can work with students on additional We Do problems. • Additional Examples – TE pg. 139, pg. 140, pg. 141 • 3-2 Reteach to Build Understanding **Online Station**: Students can watch and engage with Virtual Nerd Video lessons. Students will initially tell what they think the answer to the question is or their opinion regarding an issue, and/or their thoughts based on a prompt. Then the students will watch the video to decide as to whether their original assertion was accurate, justified, etc. • 3-2: Virtual Nerd™: How Do You Solve a Word Problem by Subtracting and Multiplying Polynomials? • 3-2: Virtual Nerd™: How Do You Solve a World Problem by Subtracting Polynomials **Offline Station:** Students would complete problems and exercises selected for the You Do in Pairs part of the lesson. • Lesson Performance Task #32 – Pg. 145 • 3-2 Additional Practice • 3-2 Mathematical Literacy and Vocabulary • 3-2 Enrichment

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7	What **manipulatives** might be integrated into the gradual release of responsibility (I Do, We Do, You Do in Pairs, You Do Without Assistance)? What did you learn from using the manipulatives **in advance** of using them in class with students?	**Reference:** Interactive Manipulatives • Didax Virtual Manipulatives • Savvas Math Tools • Realize Desmos (Graphing Calculator) • Realize Desmos (Scientific Calculator)	**Reference:** Interactive Manipulatives • Didax Virtual Manipulatives • Savvas Math Tools • Realize Desmos (Graphing Calculator) • Realize Desmos (Scientific Calculator)
8	What **graphic organizer(s)** might support students' conceptual understanding of the process outlined by the performance-based objective(s)?	**Reference:** • Graphic Organizer Templates • Google Drawing Graphic Organizers • Teacher Vision	**Reference:** • Graphic Organizer Templates • Google Drawing Graphic Organizers • Teacher Vision

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