Educational Epiphany ™

Districtwide PLC Protocol for **Mathematics**

Teacher/Teacher Team:
Grade/Course: Algebra 2
Date: Week of September 5, 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 2.2 – Standard Form of a Quadratic**	**Lesson 2.3 – Factored Form of Quadratic Function**	**Lesson 2.4 – Complex Numbers and Operations**
		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.S.ID.B.2** Represent data on two quantitative variables on a scatter plot and describe how the variables are related. **Foundational Standards:** 8.SP.A.3, A1.F.LE.A.1, A1.A.CED.A.2	**A2.A.SSE.A.1** Use the structure of an expression to identify ways to rewrite it. **Foundational Standard:** A1.A.SSE.A.1	**A2.N.CN.A.1** Know there is a complex number *i* such that $i^2 = -1$, and every complex number has the form $a + bi$ with a and b real. **Foundational Standard:** 8.EE.A.2 **A2.N.CN.A.2** Know and use the relation $i^2 = -1$ and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers. **Foundational Standard:** 7.EE.A.1
2	What **mathematical concepts** are embedded in the state standard?	**Understand that:** • A quadratic function in vertex form can be written in standard form to highlight different features of the function's graph. • The key features are used to interpret values in context. • Students create quadratic functions written in standard form. • Students use the coefficients of the quadratic and linear terms to calculate the coordinates of the vertex and the axis of symmetry. • (why) the constant term in the quadratic function provides the value of the y-intercept.	**Understand that:** • The factored form of a quadratic function is used to find the zeros of the function by identifying the values that make one or both factors equal to zero. • $y = ax^2 + bx + c$ can be written in factored form to identify the zeros of the function. • Zeros of a quadratic function are used to find the intervals of the function for which the range is positive or negative.	**Understand that:** • A complex number contains both real and imaginary parts. • The four basic operations can be applied to complex numbers. • The imaginary unit *i* is the number whose square is equation to -1, so $i^2 = -1$. They recognize that complex numbers are written in the form $a + bi$, composed of real numbers a and b and the imaginary unit *i*. • The properties of operations and the relation f$i^2 = -1$ of the four basic operations, are applied to complex

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		Students identify key features of quadratic functions and relate them to the graphs of the function.		numbers, are used to perform operations on complex numbers.
3	What teacher **knowledge, reminders, and misconceptions** are assumed in the standard?	**Knowledge:** • This lesson emphasizes a blend of conceptual understanding and application. • Students understand that the standard form a quadratic function can be used to find the vertex and axis of symmetry for the function's graph. • Students apply the standard form of a quadratic function to solve real-world problems such as projectile motion problems. • Students use the standard form of a quadratic function to represent a real-world situation where height is expressed as a function of time. • Students find relationships involving a, h, and k by converting fro vertex form to standard form and then use it to identify the key features of the function's graph, including the vertex, axis of symmetry, maximum and minimum. • Students rewrite quadratic functions in standard form. • Students graph a quadratic function written in standard form by identifying its key features. **Reminders and Misconceptions:** • Students identified the key features of a quadratic function written in vertex form and used those features to graph the function. • When b is negative, students sometimes forget to include the negative sign when calculating the x-coordinate of the vertex because there is already a negative sign in $h = -\frac{b}{2a}$. Remind students to include the negative sign in the calculation when b is negative.	**Knowledge:** • This lesson emphasizes a blend of conceptual understanding and procedural skill and fluency. • Students understand that the values that make either factor of a quadratic expression equal to zero are the zeros of the function that the expression defines. • Students use the Distributive Property and the Zero Product Property to solve quadratic equations by factoring. • Students factor a quadratic expression to find the zeros of a quadratic function. • Students use the Zero Product Property to solve quadratic equations by factoring. • Students identify factoring, completing the square and the Quadratic Formula as starting points and apply the Zero Product Property as a solution pathway for solving a quadratic equation. • Students recognize the pattern that the sign of the y-value of a test point will be the same as the y-value of any other point within a given interval they are testing. **Reminders and Misconceptions:** • Students used the structure of a quadratic equation written in vertex form or standard form to identify ways to rewrite it. • When factoring quadratics with a > 1, remind students to look for the factors of the product of the leading coefficient and the constant.	**Knowledge:** • This lesson emphasizes a blend of conceptual understanding and application. • Students understand that complex numbers include the real and imaginary numbers and that the properties of operations can be used to add, subtract, and multiply complex numbers. • Students apply their understanding of complex numbers to solve quadratic equations with complex solutions, including involving electrical circuits. • Students solve quadratic equations with complex solutions and understand that a complex number includes both real and imaginary parts. • Students use properties of operations to add, subtract and multiply complex numbers. • Students used complex numbers to represent and solve problems involving voltage sources in an electrical current. • Students generalize when they use their understanding of complex numbers and the relationship between multiplication and division to write an explicit formula that can be used to find the quotient of two complex numbers. **Reminders and Misconceptions:** • Students wrote and solved quadratic equations with real solutions.

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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 write a function defined by an expression to model a quadratic or an exponential relationship given a real-world context IOT describe a given real-world context. **(A2.F.BF.A.1)** • SWBAT fit a linear function to a given set of data, fit a quadratic function to a given set of data, or fit an exponential function to a given set of data, where exponential functions are limited to domains not in the integers, IOT solve problems in the context of the data. **(A2.S.ID.B.2a)** **Lesson objectives**: • Create quadratic functions written in standard form. Identify key features of quadratic functions and graph a quadratic function written in standard form.	**PBO:** • SWBAT rewrite expressions IOT represent the expressions in different forms. **(A2.A.SSE.A.1)** • SWBAT choose and produce an equivalent form of an exponential expression IOT generate the expression from a real-world context. **(A2.A.SSE.B.2)** • SWBAT factor a quadratic, cubic, or quartic polynomial, when suitable, and identify the zeroes, IOT construct a rough graph of the function defined by the polynomial. **(A2.A.APR.A.2)** **Lesson objectives**: • Write a quadratic equation in factored form and use it to identify the zeros of the function it defines. • Determine the intervals over which a quadratic function is positive or negative.	**PBO:** • SWBAT state that there is a complex number i such that $i2 = -1$ IOT distinguish between a real number, a pure imaginary number and a complex number. **(A2.N.CN.A.1)** • SWBAT express complex numbers in the written form a + bi, where a and b represent real numbers IOT identify whether or not solutions to problems are viable within a mathematical or real-world context. **(A2.N.CN.A.1)** • SWBAT know and the commutative, associative, and distributive properties to add, subtract, and multiply complex numbers IOT rewrite and simplify complex numbers. **(A2.N.CN.A.2)** • SWBAT solve a quadratic equation in the form $ax2 + bx + c = 0$ with real coefficients, solve by using the quadratic formula or completing the square IOT identify solutions as real or complex and to determine if all solutions are viable in the context of the problem. **(A2.N.CN.B.3)** • SWBAT solve quadratic equations and inequalities in one variable by inspection (e.g., for x2 = 49), taking square roots, completing the square, knowing and applying the quadratic formula, and factoring, as appropriate to the initial form of the equation IOT express the solutions as real numbers or as complex numbers in the form a ± bi for real numbers a and b. **(A2.A.REI.B.3)** **Lesson objectives**: • Add, subtract, and multiply complex numbers using the properties of operations and the relation $i^2 = -1$.
5	What **academic language** must be taught before the teacher models for students? How will the academic	**Academic Language:** • **context -** situation used to describe the mathematical problem • **cube root** – one of three identical factors of a number that is the product of those factors	**Academic Language:** • **choose** – decide on a course of action • **construct** – to make or create • **context** – a situation used to describe a mathematical problem	**Academic Language:** • **apply** – put to use; do • **appropriate** – suitable or proper in the circumstances

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	language be **taught and assessed**?	• **data** – a collection of information or facts • **domain** – the set of input values of a function • **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 • **function** – a relation in which every domain(input) value is paired with exactly one range(output) value. • **graph** – to plot • **identify** – to recognize and name; to make sense of and assign meaning to the data • **integers** – whole numbers and their opposites • **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. • **linear function** – a function whose graph is a line and is represented by a linear equation • **logarithmic function** – the inverse of an exponential function • **model** – to describe or show mathematically • **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) • **problem** – a question that needs a solution • **quadratic expression** – expression written with a squared term	• **cubic polynomial –** a polynomial of degree 3 • **equivalent** – equal in value • **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 • **factor** – numbers or variables that are multiplied to obtain a product or new expression • **form** - the visible shape or configuration of something • **function** – a relation in which every domain(input) value is paired with exactly one range(output) value. • **generate** – to produce • **graph** – a diagram showing the relation between variable quantities • **identify** – to recognize and name; to make sense of and assign meaning to the data • **polynomial** – an expression of more than two algebraic terms, especially the sum of several terms that contain different powers of the same variable(s) • **produce -** to create • **quadratic polynomial** – a polynomial of degree 2 • **real-world** – questions related to a concrete setting • **represent** – state or point something out • **rewrite -**to revise words, symbols, equations, expressions, etc. in a different way • **zero of a function** - a function $f(x)$ is any value of x for which $f(x)=0$ • **Zero Product Property** - If ab=0, then a=0 or b=0 or a=b=0	• **associative property** – the sum or product is the same regardless of how the numbers are grouped • **coefficient** – the leading number or variable that is multiplied by a variable in an expression or equation • **commutative property** – the sum or product of a group of numbers is the same regardless of the order in which the numbers are arranged • **completing the square** - the process of converting a quadratic equation into a perfect square trinomial by adding or subtracting terms on both sides • **complex conjugates** - number pairs of the form $a+bi$ and $a-bi$ • **complex number** – numbers that can be written in the form $a + bi$, where a and b are real numbers, and I is the square root of -1 • **complex** – complicated and intricate • **context** – a situation used to describe a mathematical problem • **determine** - to find out something using mathematical processes • **distributive property** – simplifying an expression by multiplying a number/term by each term inside the parentheses • **equation** – a mathematical statement containing an equal sign to show that two expressions are equal • **express** – to convey or communicate • **factoring** – the process of writing an equivalent expression that shows the factors of the original product • **form** – the visible shape or configuration of something • **identify** – to recognize and name; to make sense of and assign meaning to the data • **imaginary number** – the imaginary i is the principal square root of -1

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		• **quadratic function**- $f(x) = ax^2 + bx + c$, for constants a, b, c with a not equal to zero and for x any real number • **real-world** – related to a concrete setting • **relationship** – the way in which two or more concepts are connected • **solve -** to apply an operation(s) in order to find a value; to find an answer • **square root** – one of two identical factors of a number that is the product of those factors • **standard form of a quadratic function -** $ax^2 + bx + c = 0$; where a, b, c, are real numbers and a is not equal to zero • **vertex form of a quadratic function -** the equation for a parabola in the form $y = (a - h)^2 + k$ where the point (h, k) is the vertex • **write** – to create using words, symbols, equations, expressions, etc. **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)	• **zero** - an input value for a function that produces zero as the output; also known as x-intercept and root **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)	• **imaginary unit i**- the complex number whose square is –1 • **inequality** – a mathematical sentence that uses symbols (<,≤, >, ≥, ≠) to show the relationship between quantities not equal • **inspection** – careful examination • **know -** be aware of through observation, inquiry, or information • **problem** – a question that needs a solution • **quadratic equation –** an equation of degree 2, which has at most two solutions • **Quadratic formula -** a formula that provides the solution(s) to a quadratic equation $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ • **real number** – the union of the set of rational and irrational numbers • **real-world** – related to a concrete setting • **represent** – state or point something out • **rewrite -**to revise words, symbols, equations, expressions, etc. in a different way • **simplify –** producing an equivalent form; combine like terms and apply properties to make computation easier • **solution** – the answer to a problem; the value(s) of a variable that satisfies a given algebraic equation • **solve** – to find an answer • **square root** – one of two identical factors of a number that is the product of those factors. • **variable** – a quantity that changes or can have different values • **viable** – capable of working successfully **Instructional Practice 2:**

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				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. 80, pg. 81, pg. 83 • 2-2 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. • 2-2: Virtual Nerd™: How Do You Convert a Quadratic Equation form Vertex Form to Standard Form? • 2-2: Virtual Nerd™: How Do You Write an Equation for a Quadratic if You Have Three Points? **Offline Station:** Students would complete problems and exercises selected for the You Do in Pairs part of the lesson. • Lesson Performance Task #31 – Pg. 87 • 2-2 Additional Practice • 2-2 Mathematical Literacy and Vocabulary 2-2 Enrichment	**Station Rotation Model Suggestions** **Teacher-Led Station:** Teachers can work with students on additional We Do problems. • Additional Examples – TE pg. 88, pg. 89 • 2-3 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. • 2-3: Virtual Nerd™: How Do You Solve a Quadratic Equation by Factoring? • 2-3: Virtual Nerd™: What's the Zero Product Property? **Offline Station:** Students would complete problems and exercises selected for the You Do in Pairs part of the lesson. • Lesson Performance Task #45 – Pg. 94 • 2-3 Additional Practice • 2-3 Mathematical Literacy and Vocabulary • 2-3 Enrichment	**Station Rotation Model Suggestions** **Teacher-Led Station:** Teachers can work with students on additional We Do problems. • Additional Examples – TE pg. 95, pg. 96, pg. 98 • 2-4 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. • 2-4: Virtual Nerd™: How Do You Use the Square Root Method to Solve a Quadratic Equation with Imaginary Solutions if $a \neq 0$? • 2-4: Virtual Nerd™: What is the Difference Between Imaginary and Complex Numbers? **Offline Station:** Students would complete problems and exercises selected for the You Do in Pairs part of the lesson. • Lesson Performance Task #50 – Pg. 101 • 2-4 Additional Practice • 2-4 Mathematical Literacy and Vocabulary

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				• 2-4 Enrichment
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)	**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	**Reference:** • Graphic Organizer Templates • Google Drawing Graphic Organizers • Teacher Vision

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