Educational Epiphany ™
Districtwide PLC Protocol for **Mathematics**

Teacher/Teacher Team:
Grade/Course: Algebra II
Date: Week of October 17, 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 3.5 – Zeros of Polynomial Functions**	**Lesson 3.6 – Theorems About Roots of Polynomial Equations**
		• **A2.A.APR.A.2** 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. **Foundational Standard:** A1.A.SSE.B.3a • **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.A.SSE.A.1** Use the structure of an expression to identify ways to rewrite it. **Foundational Standards:** A1.A.SSE.A.1	• **A2.A.APR.A.1** Know and apply the Remainder Theorem: For a polynomial p(x) and a number a, the remainder on division by x – a is p(a), so p(a) = 0 if and only if (x – a) is a factor of p(x). **Foundational Standard:** A1.A.SSE.B.3a • **A2.A.APR.A.2** 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. **Foundational Standard:** A1.A.SSE.B.3a
2	What **mathematical concepts** are embedded in the state standard?	**Understand that:** • The zeros of a polynomial function can be determined using factoring or synthetic division. The zeros of a function can be used to sketch its graph. • Students use factoring and synthetic division to find the zeros of a polynomial function and determine how the multiplicity of a zero affects the graph of the function. • Students use the zeros of a function, including the multiplicity of each zero and whether the zero is real or complex, to sketch the graph of the polynomial function.	**Understand that:** • Theorems such as the Rational Root Theorem, the Fundamental Theorem of Algebra, and the Conjugate Root Theorems are helpful tools for determining the roots of a polynomial function. • Students use the Fundamental Theorem of Algebra to determine the number of solutions of a polynomial in the complex number system. They apply the Rational Root Theorem to identify the possible rational roots of a polynomial equation. • Students apply the Conjugate Root Theorems to find the conjugates of a polynomial expression and use them to rewrite polynomial functions.
3	What teacher **knowledge, reminders, and misconceptions** are assumed in the standard?	**Knowledge:** • The first step in developing a student's understanding of polynomials is to construct a rough graph for polynomial functions by using their zeros.	**Knowledge:** • Students should understand the relationship between the solution of a polynomial equation, the coefficient, and the degree of the polynomial.

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		• Next, begin to develop an understanding of the connection that exists between the graphical and algebraic representation of zeros and that they are not simply following a rote procedure; students should be able provide evidence of an understanding of this connection. **Reminders:** • Reinforce academic vocabulary: zeros, roots, solutions, and x-intercepts should be used interchangeably, and students should understand they are all ways of describing the same relationship. • Provide problems that are both in factored and unfactored form and have students identify the zeros. Students should then be able to sketch a rough graph of the polynomial using those zeros. • Students should be able to factor, find the zeros, and sketch a rough graph using the zeros for quadratic, cubic, and quartic polynomials. • Ensure students are given polynomials with zeros of varied multiplicities to practice factoring and sketching the rough graph. **Misconceptions:** • Students given polynomials in factored form may think they need to multiply and then refactor to find the zeros. • For example, given the following polynomial in factored form, $f(x) = 4x(x+3)(x-2)$ students may not know what to do with the factor $4x$.	• Students should understand the multiplicity of the zeros of a polynomial. • Students should understand how to use the conjugate of a given zero(s) and the degree of a polynomial to generate the polynomial. **Reminders:** • Students need experience solving all types of polynomials and should understand what theorem or strategy to use and when it is appropriate to use it. **Misconceptions:** • Students may get confused that the Rational Root Theorem generates a list of *possible* rational roots and that not all of the numbers will be zeros.
4	What **objective(s)** must be taught? In what order? Why?	**PBO:** • **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**: • Identify the zeros of a function by factoring or using synthetic division. • Use the zeros of a polynomial function to sketch its graph.	**PBO:** • **SWBAT** explain each step in solving a square root, cube root, polynomial, rational, and logarithmic equation using multiple solution strategies IOT construct a viable argument to justify a chosen solution method used. **Lesson objectives**: • Extend polynomial theorems and identities to find the real and complex solutions of polynomial equations. • Write polynomial functions using conjugates.
5	What **academic language** must be taught before the teacher models for students? How will the academic language be **taught and assessed**?	**Academic Language:** • **Construct** – to make or create • **Cubic polynomial –** a polynomial of degree 3 • **Factor** – numbers or variables that are multiplied to obtain a product or new expression • **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 • **Identify** – to recognize and name; to make sense of and assign meaning to the data	**Academic Language:** • **Argument** – words presented with the aim of persuading thought or action • **Construct** – to make or create • **Cube root** – one of three identical factors of a number that is the product of those factors • **Equation** – a mathematical statement containing an equal sign to show that two expressions are equal • **Explain** – make clear by describing; to make something clear by describing it in more detail or by revealing relevant facts or ideas

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		• **Polynomial** – an expression of more than two algebraic terms, especially the sum of several terms that contain different powers of the same variable(s) • **Quartic polynomial** – a polynomial of degree 4 • **Quadratic polynomial** – a polynomial of degree 2 • **Zero** – an input value for a function that produces zero as the output; also known as x-intercept and root • **Multiplicity of a Zero** – the number of times the related linear factor is repeated in the factored form of the polynomial. **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)	• **Justify** – to prove or show to be correct or reasonable • **Logarithm** – for b>0, b≠1, and x≠1, the logarithm base b of a positive number x is defined as follows: $\log_b x = y$ if and only if $x = b^y$ • **Polynomial** – an expression of more than two algebraic terms, especially the sum of several terms that contain different powers of the same variable(s) • **Rational** – any number that can be written as a ratio • **Solution** – the answer to a problem; the value(s) of a variable that satisfies a given algebraic equation • **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 • **Strategy** – a method or way of solving a problem • **Viable** – capable of working successfully • **Rational Root Theorem** – If the polynomial equation P(x)=0 has any rational roots, then each rational root is of the form $\frac{p}{q}$, where p is a factor of the constant term and q is a factor of the leading coefficient. • **Fundamental Theorem of Algebra –** If P(x) is a polynomial of degree $n \geq 1$, then P(x)=0 has exactly n solutions in the set of complex numbers. If P(x) has any factor of multiplicity m, count the solution associated with that factor m times. For example, the equations $(x-3)^4 = 0$ has four solutions, each equal to 3. **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**	**Station Rotation Model Suggestions** **Teacher-Led Station:** Teachers can work with students on additional We Do problems. • 3-5 Reteach to Build Understanding **Online Station**: Students can engage with the Savvas Realize Model & Discuss or engage with MathXL for School: Additional Practice • 3-5 Model and Discuss	**Station Rotation Model Suggestions** **Teacher-Led Station:** Teachers can work with students on additional We Do problems. • 3-6 Reteach to Build Understanding **Online Station**: Students can engage with the Savvas Realize Critique & Explain, engage with MathXL for School: Additional Practice, or watch and engage with a Virtual Nerd Video

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	advance of using them in class with students?	• 3-5: Math XL for School: Additional Practice **Offline Station:** Students would complete problems and exercises selected for the You Do in Pairs part of the lesson. • Lesson Performance Task #30 – Pg. 169 • 3-5 Additional Practice	• 3-6 Critique & Explain • 3-6: Math XL for School: Additional Practice • Virtual Nerd: How do you find all the rational zeros of a polynomial function? • Virtual Nerd: What is the Rational Zero Theorem? **Offline Station:** Students would complete problems and exercises selected for the You Do in Pairs part of the lesson. • Lesson Performance Task #38 – Pg. 178 • 3-6 Additional Practice
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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