Educational Epiphany ™

Districtwide PLC Protocol for **Mathematics**

Teacher/Teacher Team:
Grade/Course: Algebra 2
Date: Week of September 19, 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 2.6 – The Quadratic Formula** **A2.A.REI.B.3** Solve quadratic equations and inequalities in one variable. **a.** Solve quadratic equations by inspection (e.g., for $x^2 = 49$), taking square roots, completing the square, knowing and applying 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 $a \pm bi$ for real numbers a and b. **Foundational Standards:** A1.A.REI.B.3a, A1.A.SSE.B.3a **A2.N.CN.B.3** Solve quadratic equations with real coefficients that have complex solutions. **Foundational Standards:** None	**Lesson 2.7 – Linear – Quadratic Systems** **A2.A.REI.C.5** Solve a system consisting of a linear equation and a quadratic equation in two variables algebraically and graphically. **Foundational Standards:** None **A2.A.REI.D.6** 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 approximate solutions using technology. ★ **Foundational Standards:** None
2	What **mathematical concepts** are embedded in the state standard?	**Understand that:** • The Quadratic Formula can be used to solve any quadratic equation, including those with complex solutions. • Students derive the Quadratic Formula by completing the square. They understand that this formula can be used to find the solutions to any quadratic equation. • Students understand that they can use the value of discriminant $b^2 - 4ac$ to predict the number and type of solutions to a quadratic equation. They use complex numbers to represent solutions for quadratic equations with non-real solutions.	**Understand that:** • A linear-quadratic system consists of a linear equation and a quadratic equation. • The points of intersection are the solutions. • Students use substitution or elimination to solve a linear-quadratic system of equations. They also approximate solutions to a linear-quadratic system by graphing. The relate the number of solutions to the system to the number of points of intersection of the graphs of the equations. • Students graph the solutions to linear-quadratic systems of inequalities. They consider whether the graph is solid or doted and use shading to identify the solution region. They recognize that the solution region represents the points that satisfy both the linear and the quadratic inequalities.
3	What teacher **knowledge, reminders, and misconceptions** are	**Knowledge:** • This lesson emphasizes a blend of conceptual understanding and application.	**Knowledge:** • This lesson emphasizes a blend of conceptual understanding and application.

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	assumed in the standard?	• Students recognize when the Quadratic Formula gives complex solutions and write the solutions in the form $a + bi$. • Students interpret the discriminant within the context of real-world problems involving projectile motion. • Students use completing the square to derive the Quadratic Formula and then use the Quadratic Formula to solve quadratic equations with real and complex roots. • Students analyze problems and use stated mathematical assumptions and definitions to construct arguments to justify each step in the derivation of the Quadratic Formula. • Students recognize the strengths and limitations of the Quadratic Formula as a useful tool for solving quadratic equations that cannot be easily factored. **Reminders and Misconceptions:** • Students used factoring and completing the square to solve quadratic equations with real roots. • Students used complex numbers to represent numbers with both real and imaginary parts. • Students may think that when the discriminant is negative, there are no solutions. Remind them that a negative discriminant means there are no real solutions, but there are two complex solutions. • When using the Quadratic Formula, students often forget to start with -b, especially when the value of b is negative to begin with. Remind students to be diligent when evaluating the formula.	• Students understand the points of intersection of a linear-quadratic system represent the solutions to the system. • Students create and solve a linear-quadratic system to find points of interaction in real-world problems such as finding where the path of a ball intersects with a hill. • Students use mathematical assumptions and established results to construct an argument about the number of possible intersections between a linear and a quadratic function. • Students apply the structure used to solve systems of linear equations to solve linear-quadratic systems by substitution and elimination. • Students solve linear-quadratic systems in two variables algebraically and graphically. • Students explain why the points where the graphs intersect are the solutions to the system. **Reminders and Misconceptions:** • Students solved and graphed linear and quadratic equations. • Students may make computational errors when trying to determine the number of solutions of an equation algebraically. Have students sketch a graph for this system to estimate the number of real solutions. Emphasize that if the two graphs do not intersect, then the system has no real solutions.
4	What **objective(s)** must be taught? In what order? Why?	**PBO:** • 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)** • SWBAT create one variable linear, quadratic, rational, or exponential equations and inequalities IOT use them to solve real-world situations. **(A2.A.CED.A.1)** **Lesson objectives**:	**PBO:** • 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)** • SWBAT write and solve a system of linear equations in two or three variables IOT solve a real-world situation. **(A2.A.REI.C.5)** • SWBAT justify why a system consisting of a linear equation and a quadratic equation may have no solution, one solution, or two solutions IOT understand the reasonableness of the solution in a real-world context. **(A2.A.REI.C.5)** • SWBAT 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) IOT solve the problem in a real-world context. **(A2.A.REI.D.6)**

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		• Use the Quadratic Formula to solve quadratic equations that have complex solutions.	• SWBAT approximate the solution(s) for f(x) = g(x) using technology including when f(x)and g(x) are non-linear, non-quadratic polynomial; rational; exponential; or logarithmic functions, given two equations f(x) and g(x) IOT solve a real-world situation. **(A2.A.REI.D.6)** **Lesson objectives**: • Use algebra to solve a linear – quadratic system. • Solve a linear – quadratic system using graphing and explain why the points of intersection are the solutions.
5	What **academic language** must be taught before the teacher models for students? How will the academic language be **taught and assessed**?	**Academic Language:** • **apply** – put to use; do • **appropriate** – suitable or proper in the circumstances • **coefficient** – the leading number or variable that is multiplied by a variable in an expression or equation • **completing the square** - the process of converting a quadratic equation into a perfect square trinomial by adding or subtracting terms on both sides • **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 • **create** – to produce or generate • **determine** - to find out something using mathematical processes • **discriminant** - the value of the expression $b^2 - 4ac$ of a quadratic equation in the form $ax^2 + bx + c = 0$. The value of the discriminant determines the number of solutions of the equation. • **equation** – a mathematical statement containing an equal sign to show that two expressions are equal • **exponential equation –** an equation that contains the form b^{cx}, with the exponent including a variable • **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 • **inequality** – a mathematical sentence that uses symbols (<,≤, >, ≥, ≠) to show the relationship between quantities not equal • **inspection** – careful examination	**Academic Language:** • **apply** – put to use; do • **appropriate** – suitable or proper in the circumstances • **completing the square** - the process of converting a quadratic equation into a perfect square trinomial by adding or subtracting terms on both sides • **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 • **context** – a situation used to describe a mathematical problem • **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 • **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 $y = a(1 - r)^x$ • **express** – to convey or communicate • **factoring** – the process of writing an equivalent expression that shows the factors of the original product • **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. • **inequality** – a mathematical sentence that uses symbols (<,≤, >, ≥, ≠) to show the relationship between quantities not equal • **inspection** – careful examination • **intersect –** cross • **justify** – to prove or show to be right or reasonable • **know -** be aware of through observation, inquiry, or information

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		• **know -** be aware of through observation, inquiry, or information • **linear equation–** an equation that can be written in the form ax + by = c • **perfect square trinomial -** a trinomial that is the square of a binomial • **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 • **radical -** an expression containing a root • **radicand -** a number or expression under the radical symbol • **rational** – a real number that can be written as a ratio • **real number** – the union of the set of rational and irrational numbers • r**eal-world** – relating to a concrete setting • **situation -** a set of circumstances in which one finds oneself; a state of affairs • **solution** – the answer to a problem; the value(s) of a variable that satisfies a given algebraic equation • s**olve** – 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. • **use** – take or hold; apply; deploy (something) as a means of accomplishing a purpose or achieving a result • **variable** – a quantity that changes or can have different values • **viable** – capable of working successfully **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)	• **linear equation–** an equation that can be written in the form ax + by = c • linear system - a set of two or more linear equations that use the same variables • **linear function** – a function whose graph is a line and is represented by a linear equation • linear-quadratic system - a system of equations that includes a linear equation and a quadratic equation and is represented on a graph by the corresponding line and parabola • **logarithmic function** – a quantity representing the power to which a fixed number (the base) must be raised to produce a given number. • **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 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 • **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 • **rational** – any number that can be written as a ratio • **real number** – the union of the set of rational and irrational numbers • **real-world** – questions related to a concrete setting, related to a concrete setting • **situation -** a set of circumstances in which one finds oneself; a state of affairs • solution of a system - a set of values for the variables that makes all the equations true • **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 • **square root** – one of two identical factors of a number that is the product of those factors. • **system of equations** –a collection of two or more equations with the same set of unknowns • **system of linear equations** –two or more linear equations with the same set of unknowns

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			• **understand** – comprehend; grasp the intended meaning of; infer something from information received • **variable** – a quantity that changes or can have different values • **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)
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. 110, pg. 111, pg. 113 • 2-6 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. • 2-6: Virtual Nerd™: How Do You Solve a Quadratic Equation with Complex Solutions by Using the Quadratic Formula? • 2-6: Virtual Nerd™: How do You Find the Discriminant of a Quadratic Equation with 2 Complex Solutions? **Offline Station:** Students would complete problems and exercises selected for the You Do in Pairs part of the lesson. • Lesson Performance Task #39 – Pg. 116 • 2-6 Additional Practice • 2-6 Mathematical Literacy and Vocabulary • 2-6 Enrichment	**Station Rotation Model Suggestions** **Teacher-Led Station:** Teachers can work with students on additional We Do problems. • Additional Examples – TE pg. 117, pg. 118 • 2-7 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. • 2-7: Virtual Nerd™: How Do You Solve a Linear-Quadratic System Using Substitution? **Offline Station:** Students would complete problems and exercises selected for the You Do in Pairs part of the lesson. • Lesson Performance Task #29 – Pg. 123 • 2-7 Additional Practice • 2-7 Mathematical Literacy and Vocabulary • 2-7 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)?	**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)

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	What did you learn from using the manipulatives **in advance** of using them in class with students?		
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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