Sample Mathematics Learning Plan

Big Idea/ Topic
• Graph different types of functions and analyze, solve, and interpret quadratic equations with complex solutions.

Standard(s) Alignment
MGSE9-12.F.IF.7 Graph functions expressed algebraically and show key features of the graph both by hand and by using technology. **MGSE9-12.F.IF.7a** Graph linear and quadratic functions and show intercepts, maxima, and minima (as determined by the function or by context). **MGSE9-12.F.IF.8** Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function. **MGSE9-12.F.IF.8a** Use the process of factoring and completing the square in a quadratic function to show zeros, extreme values, and symmetry of the graph, and interpret these in terms of a context. *For example, compare and contrast quadratic functions in standard, vertex, and intercept forms.* **MGSE9-12.F.IF.8b** Use the properties of exponents to interpret expressions for exponential functions. *For example, identify percent rate of change in functions such as* $y = (1.02)^t$, $y = (0.97)^t$, $y = (1.01)^{(12t)}$, $y = (1.2)^{(t/10)}$, and classify them as representing exponential growth and decay.

Diagnostic Assessment
When completing the diagnostic assessment task found at the link below: • Students will match quadratic equations to their graphs. • Students will identify x-intercepts, y-intercepts, and the vertex by looking at the graph of a quadratic equation. • Given the vertex and y-intercept, students will write the equation of a quadratic function.

Link to sample diagnostic assessment.

This assessment task can be used to diagnose students' level of understanding of the big idea and standards addressed in this learning plan.

Instructional Design

Engage

- **Synchronous** or **Asynchronous-** Desmos Activity: Will it Hit the Hoop? In this activity, students predict whether various basketball shots will go through the hoop, and then model these shots with parabolas to check their predictions. Students use draggable points to model in this activity and do not need to be familiar with symbolic forms of quadratic functions in advance. Teacher guide for synchronous facilitation.
- **Synchronous**- Falling Rock Three Act Math Task. In this 3-Act Math Task, students compare the time it takes a rock to fall to estimate the depth of a chasm. Click here to read more about facilitating 3-Act Math Tasks. Students love them!
- **Unplugged/ Offline** – Ted's Quest for a Tablet In this activity, students create equations (of one to three variables) in order to model some realistic phenomena. This activity includes: creating a table, graphing, vocabulary development, and additional practice with quadratics.

Explore

- **Synchronous** or **Asynchronous** - Desmos Activity: Marbleslides: Parabolas In this activity, students will transform parabolas so that the marbles go through the stars. Students will test their ideas by launching the marbles and will have a chance to revise before trying the next challenge. Teacher guide for synchronous facilitation.
- **Unplugged/ Offline** - Maximum and Minimum Values Graphing Calculator Activity In this activity, students will use a graphing calculator to explore and reflect on the effects of changing the a, b, and c values in quadratic equations.

Apply

- **Synchronous** or **Asynchronous** – Desmos Activity: Match My Parabola In this activity, students work through a series of scaffolded quadratic graphing challenges to develop their proficiency with standard, vertex, factored, and other quadratic function forms. Teacher Guide.

- **Unplugged/ Offline** Provide students with pages 3-5 of this Quadruple Quadratics Matching activity by Cameo Lutz. Directions to students: Match each graph to its standard form, vertex form, intercept form and x- and y- intercepts. Glue or tape all five cards to the same sheet of paper. Answer the following questions (from page 2 of the activity):
    1. Name one key feature that helped you match a *graph* with its *Standard Form.*

2. Name one key feature that helped you match a *graph* with its *Vertex Form.*
3. Name another key feature that helped you match *Standard Form* with a *description.*

Reflect

Students will create a Frayer Model graphic organizer to describe what they know about graphs of quadratic equations: What it IS, What it IS NOT, Examples, and NON-Examples.

- **Synchronous** Think-pair-share. First, students work independently to *think* about what they know and complete the Frayer Model. Next, students pair up and share their models with each other. Finally, students engage in a large group discussion to discuss their models. If you're working synchronously *online*, you might explore your ability to have breakout rooms to allow students to work in groups.
- **Asynchronous** Virtual Think-Pair-Share. First, students work independently to *think* about what they know and complete the Frayer Model. If you're able to group your students, you might consider having them work together to complete the Frayer
- **Unplugged/ Offline** Provide students a blank template of a Frayer Model and instruct them to complete it with information about Equivalent Equations.

Evidence of Student Success

Three formative assessments are suggested during the learning process. The first occurs during the Engage portion of the lesson which provides insight on students' understandings and misunderstandings. The second formative assessment occurs during the Apply portion of the lesson when conducted synchronously or asynchronously. The final formative assessment should be collected to inform future instruction.

Ideas for summative assessments:

Synchronous or **Asynchronous:** Modeling Quadratics Basketball Video Project. Students will use their own video footage of a basketball going into a hoop to write quadratic equations, individually or in groups. Students will make inferences about the accuracy of the basketball shot using their equations. There are a variety of ways students could present and share their work including FlipGrid (click here for a FlipGrid teacher's guide).

Synchronous Asynchronous, or **Offline**: Angry Birds Quadratic Graphing. Students manipulate quadratic equations to try to hit the pig off the platform by launching an angry bird.

Synchronous, Asynchronous, or **Offline:** Quadratics Revisited Project Students demonstrate their understanding of manipulating quadratic equations to represent real world scenarios.

Student Learning Supports and Support Class Suggestions

At all grades, the mathematics big ideas encourage students to reason mathematically, to evaluate mathematical arguments both formally and informally, to use the language of mathematics to communicate ideas and information precisely, and to make connections among mathematical topics and to other disciplines. The following strategies are intended to support students who are struggling to progress towards this goal:

- ***Conceptual Processing:*** Utilize the Concrete-Representational-Abstract instructional sequence to support students in making connections among mathematical ideas, facts and skills, and reflecting upon and refining one's own understanding of relationships, generalizations and connections.
- ***Language:*** Strategically select language routines to support students in describing strategies, explaining their reasoning, justifying solutions and making persuasive arguments.
- ***Visual-Spatial Processing:*** Provide opportunities for students to engage with visual representations and manipulatives (virtual or concrete) as they solve problems, explore concepts and communicate ideas.
- ***Organization:*** Teach problem-solving strategies and problem types, as seen in the Mathematics Glossary: K – 12, in order to support students in figuring out how to get started, carrying out a meaningful sequence of steps while solving problems, keeping track of the information from prior steps, monitoring their own progress and adjusting strategies accordingly.
- ***Memory:*** Focus on conceptual strategies and patterns for computation, providing a scaffold for students who struggle with basic facts and carrying out written algorithms.

Here are some activities and tasks that can be incorporated to support students on their learning journey:

- **Synchronous** or **Asynchronous**, online, have students **explore** quadratic functions using this simulator. In written form, have students **reflect** on what happens as a, b, and c increase and decrease. Be sure to encourage them to use positive and negative values for a, b, and c. This can be used for both remediation *and* acceleration, helping students make connections between the values of a, b, and c.
- **Synchronous** or **Asynchronous**: Have students **explore** these examples of how quadratic functions can be used to model real-world scenarios. As a **reflection activity**, have students write their own example, including multiple representations of the scenario (i.e. quadratic equation, graph, chart, etc.).

Additional Extension Activities:

- Maximum and Minimum Values Graphing Calculator Activity Students use a graphing calculator to explore the effects of changing the a, b, and c values in quadratic equations.

- Math in Basketball Lesson Plan Through a series of video clips, students describe scenarios where athletes use mathematics in basketball. Students will identify strategies, create tables and graphs, and eventually solve quadratic equations using multiple methods. This would be a great activity for a support class. This activity would be best in a synchronous or asynchronous lesson, with access to the internet.

Engaging Families

- GAVS review of Graphing Quadratic Functions including a self-assessment Students and caregivers can work alongside each other to review the basic features of graphs of quadratic functions. This review includes videos and practice problems.
- Terminology review (flashcards) Caregivers and students can work together to learn and review key terminology around quadratic functions.
- Khan Academy Review of Quadratic Functions for caregivers with videos and additional practice problems.