High School Algebra Sample - Roadmap to Implementing High Quality Mathematics Instruction

The Roadmap to Implementing High Quality Mathematics Instruction seeks to **ground instruction in the *Kentucky Academic Standards (KAS) for Mathematics*, thus reaffirming a commitment to equitable learning opportunities for all Kentucky students.**

How did we get here:

As much of the information in this first section of the Roadmap relates to clarity around the standard and ensuring the learning experience is aligned to grade-level *KAS for Mathematics*, educators might begin by exploring the connection between these two resources:

- High School Algebra Breaking Down a Standard sample for KY.HS.A.2:
  Designed to mirror the architecture of the *KAS for Mathematics*, the Breaking Down a Mathematics Standard resource supports clarity by guiding educators to look deeply at the components of the architecture of the standards, contributing to a holistic understanding of the *KAS for Mathematics*, and the instructional implications resulting from that exploration, including the impact on student learning.
- High School Algebra Assignment Review Protocol for KY.HS.A.2:
  A protocol intended to help answer the question, "Does this task give students the opportunity to meaningfully engage in worthwhile grade-appropriate content?"

KAS for Mathematics	**Cluster:**	**Learning Experience:**
KY.HS.A.2	Interpret the structure of expressions	Illustrative Mathematics: Graphs of Quadratic Functions

Identify the Target of the Standard(s):

✓ **Conceptual Understanding** refers to understanding mathematical concepts, operations and relations. Conceptual understanding is more than knowing isolated facts and methods; students should be able to make sense of why a mathematical idea is important and the kinds of contexts in which it is useful. Conceptual understanding allows students to connect prior knowledge to new ideas and concepts.

✓ **Procedural Skill/Fluency** is the ability to apply procedures accurately, efficiently, flexibly and appropriately. It requires speed and accuracy in calculation while giving students opportunities to practice basic skills. Students' ability to solve more complex application and modeling tasks is dependent on procedural skill and fluency

☐ **Application** provides a valuable context for learning and the opportunity to solve problems in a relevant and a meaningful way. It is through real-world application that students learn to select an efficient method to find a solution, determine whether the solution(s) makes sense by reasoning and develop critical thinking skills.

Identify the Practice Standard(s):

May reference *Engaging the SMPs: Look fors & Question stems*

☐ MP.1. Make sense of problems and persevere in solving them.

✓ MP.5. Use appropriate tools strategically.

- ❑ Why did you use this method to solve the problem?
- ❑ What can using a ____ show us that ____ may not?
- ❑ Why was it helpful to use ____?

- ☐ MP.2. Reason abstractly and quantitatively.
- ☐ MP.3. Construct viable arguments and critique the reasoning of others.
- ☐ MP.4. Model with mathematics.
- ☐ MP.6. Attend to precision.
- ✓ MP.7. Look for and make use of structure.
  - ❑ How is ___ related to ___?
  - ❑ Why is this important to the problem?
  - ❑ How can you use what you know to explain why this works?
  - ❑ What patterns do you find in ____? How do you know ____ is a pattern?
- ✓ MP.8. Look for and express regularity in repeated reasoning.
  - ❑ How could this problem help you solve another problem?
  - ❑ Can you find a shortcut to solve the problem?
  - ❑ How would your shortcut make the problem easier?

How did we get here: As educators begin considering what this learning experience might look like and feel like with students, the *Engaging the SMPs: Look fors and Question Stems* can be a really great place to start. For this learning experience, questions from MP.5, MP.7 and MP.8 felt like a natural fit to keep in mind when considering how to move student thinking forward while not taking away the thinking away from the student.

The Roadmap to Implementing High Quality Mathematics Instruction seeks to **support intentional integration of evidence-based instructional practices.**

Identify Evidence-based Instructional Practice(s)
May reference *Effective Mathematics Teaching Practices (NCTM)*

- ☐ EMTP 1: Establish mathematics goals to focus learning.
- ☐ EMTP 2: Implement tasks that promote reasoning and problem solving.
- ☐ EMTP 3: Use and connect mathematical representations.
- ☐ EMTP 4: Facilitate meaningful mathematical discourse.
- ☐ EMTP 5: Pose purposeful questions.
- ✓ EMTP 6: Build procedural fluency from conceptual understanding.
- ☐ EMTP 7: Support productive struggle in learning mathematics.
- ☐ EMTP 8: Elicit and use evidence of student thinking.

Teacher Actions:	Student Actions:
☐ Providing students with opportunities to use their own reasoning strategies and methods for solving problems. From the in-task supports: A natural extension of this task is to have the students share some of the different equations that they found for a given condition and have them graph two or more simultaneously. For example, students could	☐ Making sure that they understand and can explain the mathematical basis for the procedures that they are using. Provide sentence stems for students to choose from in their response, such as: • Analysis: How would you explain…? What is the importance of …? • Clarification: Explain how … What is meant by …? • Cause and Effect: What connection is there between …?

graph three different equations that all have the same x-intercepts and discuss the effect that the different constant factors have on the graph.

☐ Asking students to discuss and explain why the procedures they are using work to solve particular problems.

From the in-task supports:
Parts (b) and (c) lead to important discussions about the value of different forms of equations, culminating in a discussion of how we can convert between forms and when we might want to do so.

☐ Connecting student-generated strategies and methods to more efficient procedures as appropriate.

☐ Using visual models to support students' understanding of general methods.

From the in-task supports:
This exploration can be done in class near the beginning of a unit on graphing parabolas. Students need to be familiar with intercepts, and need to know what the vertex is. It is effective after students have graphed parabolas in vertex form ($y=a(x–h)^2+k$), but have not yet explored graphing other forms. Part (a) is not obvious to them; they are excited to realize that equivalent expressions produce the same graph.

☐ Providing students with opportunities for distributed practice of procedures.

- Comparison: What is the difference between …? How are they alike?

☐ Demonstrating flexible use of strategies and methods while reflecting on which procedures seem to work best for specific types of problems.

Within part c, each of these problems has many possible answers. Asking students for three possible answers is a great extension for students - it gets them thinking about the effects of the different parts of the equation.

☐ Determining whether specific approaches generalize to a broad class of problems.

From the Attending to the SMPs within the *KAS for Mathematics*:

Students describe the meaning of parts of an expression, such as a particular term or coefficient and explain the meaning of the full expression (MP.7). Students fluently manipulate expressions into equivalent forms, based on patterns they have noticed across problems (MP.8).

☐ Striving to use procedures appropriately and efficiently.

How did we get here:

Within the Clarifications section of the KAS for Mathematics is the statement:

Additionally, students see there are three commonly used forms for a quadratic expression:

- *Standard form*
- *Factored form*
- *Vertex form*

and can identify when one form might be more useful than another.

In reading that clarification there are clear connections to the EMTP 6, such as Teacher Action, "Asking students to discuss and explain why the procedures they are using work to solve particular problems" and Student Action, "Determining whether specific approaches generalize to a broad class of problems."

The Roadmap to Implementing High Quality Mathematics Instruction seeks to **expand educator familiarity with strategies to interweave the development of social emotional competencies with development of mathematics content.**

Identify the Competency Intended to Support the Evidence-Based Instructional Practice:
May reference *Integrating SEAD within the KAS for Mathematics* resource library

☐ SELF-AWARENESS	☐ SELF-MANAGEMENT	✓ SOCIAL AWARENESS	☐ RELATIONSHIP SKILLS	☐ RESPONSIBLE DECISION-MAKING

Specific Design Considerations from *Integrating SEAD within the KAS for Mathematics* Grade Level Resource

Lead class activities that offer students the opportunity to share their perspectives and learn from the perspectives of others. Communicate that students' thinking is valued to build trust and rapport by asking questions that elicit students' thinking. Utilize activities, like Which One Doesn't Belong, to engage high school students in explaining their approach to a problem, critiquing the solutions of others and comparing the different approaches in terms of whether they are accurate and efficient (MP.3).

Position students as competent by valuing different contributions students make when they are paying close attention to the structure of an equation and identifying when one form might be more useful than another. Translating between multiple representations helps students understand each form represents the same relationship and provides a different perspective on the relationship, especially when students compare and contrast different characteristics of functions to connect features of the graph with different real-world contexts (MP.3, MP.6). Engage students in making connections among mathematical representations to deepen understanding of mathematics concepts and procedures as tools for problem solving (NCTM, 2014).

Teacher Reflection Questions from *Integrating SEAD within the KAS for Mathematics* Grade Level Resource

How might I elevate the importance of exploring math concepts as opposed to seeking the "right" answer?

Part c of this task naturally elevates the importance of exploring math concepts as students are making up an equation for a quadratic function whose graph satisfies the given condition. Building in time for students to share their thinking, perhaps via a Gallery Walk, can emphasize there is more than one "right answer". Students could also create their own Which One Doesn't Belong for their peers to engage with. Focusing on developing their own prompt where more than one answer could be correct, based on the perspective of the viewer, might be helpful to emphasize this as well.

Do I select the instructional strategies I use according to the target of the standard I am teaching? Is there anything I might want to shift about my current approach?

With this standard it is critical that students connect concepts with procedures. Conceptual understanding is more than knowing isolated facts and methods; students should be able to make sense of why a mathematical idea is important and the kinds of contexts in which it is useful. Selecting this task supports the development of that foundational understanding and how procedures can be leveraged in support of understanding the context being explored.

Moving forward I might consider ways to incorporate Routines for Reasoning, such as Connecting Representations. Connecting Representations is an instructional routine that positions students to think structurally as they connect two representations by articulating the underlying mathematics. An essential goal of this routine is expanding students' repertoire of structural noticings (MP.7).

How did we get here:

The *KAS for Mathematics* reflect the value of discussion and the view that learning is a social process, implicitly calling for teaching practices that leverage the power of a positive classroom climate and opportunities for collaborative learning. Engaging students in this task can support the development of social awareness as students have opportunities to take others' perspectives and recognize strengths in others. Mentioned briefly in the Teacher Actions above, engaging students in discussion related to the different forms of a quadratic function and having them share their thinking about why and when one form might be more useful than another is critical to engaging students in the mathematical content and practices identified above. For more information and support considering how to promote mathematical discourse, access the *Discussion and the KAS for Mathematics* resource.