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

The Roadmap to Implementing High-Quality Mathematics resource, as well as the Roadmap Overview, are available on www.kystandards.org.

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 Functions Breaking Down a Standard sample for KY.HS.F.8:
  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 Functions Assignment Review Protocol for Desmos Activity: What's My Transformation?
  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.F.8	Build new functions from existing functions	Desmos Activity: What's My Transformation?

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.
  - What can using a ____ show us that a ____ may not?
  - Why was it helpful to use ____?

☐ MP.2. Reason abstractly and quantitatively.	☐ MP.6. Attend to precision.
✓ MP.3. Construct viable arguments and critique the reasoning of others. • Did you try a method that did not work? Why didn't it work? Would it ever work? Why or why not? • How is your answer different than ___'s?	☐ MP.7. Look for and make use of structure.
☐ MP.4. Model with mathematics.	✓ MP.8. Look for and express regularity in repeated reasoning. • What predictions or generalizations can you make? • How could this problem help you solve another problem?

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.3, MP.5 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. Several of these questions build upon the functionality within Desmos that allows students to engage with one another's responses.

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

Teacher Actions:	**Student Actions:**
☐ Anticipating what students might struggle with during a lesson and being prepared to support them productively through the struggle.	☐ Struggling at times with mathematics tasks but knowing that breakthroughs often emerge from confusion and struggle.
☐ Giving students time to struggle with tasks, and asking questions that scaffold students' thinking without stepping in to do the work for them. It is important to give ample time for students to work through this activity. The activity is designed so that students can try over and over again. Throughout the activity students change different variables to see	✓ Asking questions that are related to the sources of their struggles and will help them make progress in understanding and solving tasks. Students usually struggle through this assignment. Note: Teachers may want to edit the activity and design each slide so that students have to put some type of answer before it will let them move until the next slide.

the effects of each on the graph and how that relates to the function's equation. When students get frustrated and want to give up or just know the answer so they can move on, I stop and show different student examples with some wrong and some correct from the Desmos Teacher Dashboard. Then I ask questions to help determine what our error or misconception was until the student finds the correct answer. ✓ Helping students realize that confusion and errors are a natural part of learning, but facilitating discussions on mistakes, misconceptions and struggles. Productive struggle is something you should incorporate into your lessons small activities at a time until students realize it is not acceptable to give up. Throughout the activity teachers can pause the class and lead discussion around whether it is possible to match all the functions on the screen and which is most challenging. During discussion teachers may ask students to describe the necessary transformations in words. Start with informal math language and reasoning, then help them to move towards more formal responses. As teachers use the dashboard to monitor student progress, they can identify and address any typographical errors. ☐ Praising students for their efforts in making sense of mathematical ideas and perseverance in reasoning through problems.	Using the Teacher Dashboard to display snapshots of students' answers or provide personalized feedback also helps motivate students to continue persevering through the activity. ✓ Persevering in solving problems and realizing that it is acceptable to say, "I don't know how to proceed here," but it is not acceptable to give up. Encourage students to use the question stems, 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 …?" ○ Comparison: "What is the difference between …? How are they alike?" The stems offer students options for what to say other than "I don't know what to do", equipping them to ask questions to help move their own thinking forward. ☐ Helping one another without telling their classmates what the answer is or how to solve the problem.

How did we get here: EMTP 7 feels like a natural fit for this Desmos activity as the nature of the activity is for students to explore and develop their own conceptual understanding of transformations of functions. This lesson specifically "helps students realize that confusion and errors are a natural part of learning" as they explore via the idea that all lines are related to each other, as are all parabolas. Perseverance will be key as students extend that idea to a new function type and manipulate it to gain understanding with symbolic representations of function transformations. The Teacher Guide provided with the activity offers recommendations for supporting student success and ideas on how to leverage the features within the Teacher Dashboard to enhance student learning.

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	☐ RESPONSIBLE

			SKILLS	DECISION-MAKING

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

Cultivate opportunities for students to make conjectures and build a logical progression of statements to explore the truth of their conjectures. As high school students build on middle school understanding about functions, students might analyze cases to determine the effects of transformations on the graph of a function (KY.HS.F.8). Students use technology to explore how changing the value a constant impacts the graph of the function (MP.5) and use graphical representations to create plausible arguments about the effects of transformations, instead of relying on computational rules (MP.3). Embedded time and space for student reflection can have a significant impact on how well students are able to manage their emotions and express personal agency around the mathematics being learned. Consider how to support and equip students to take the initiative and move learning forward.

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

How might I support students in working through problems without taking the thinking away from them?

In the past, I have found myself initially giving students time to struggle and then giving in and just telling them how to find the solution. Sometimes even when I am questioning the student, I worry I am just leading them to the correct answer instead of leading their thought processes in the right direction. This is an opportunity for growth for me moving forward.

What opportunities for student reflection are embedded within my plan for instruction?

Students answer the following reflection questions on the weekly check in the week of this learning experience:

- What emotions did you feel while completing the What's My Transformation activity? (Students select from choices)
- Explain one concept you learned from the What's My Transformation activity.
- If we have f(x+8), will it always move the function 8 units left? (Answer choices: always, sometimes - depends on specific function type, never)

I would like to have something that keeps all the reflections for each unit together so students could also look at their growth from the beginning of the unit until the end.

How did we get here: Focusing on self-management is a natural fit to support EMTP 7, especially as student action, "Persevering in exploring and reasoning through tasks" will be needed to engage in this learning experience. Throughout the activity teachers can pause the class and lead discussion around whether it is possible to match all the functions on the screen and which is most challenging. During discussion teachers may ask students to describe the necessary transformations in words. Start with informal math language and reasoning, then help them to move towards more formal responses. Supporting student self-management was critical to engaging students fully in the mathematics of this learning experience.