High School Statistics and Probability 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 Statistics and Probability Breaking Down a Standard sample for KY.HS.SP.6:
  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 Statistics and Probability Assignment Review Protocol for the Statistics Task from Writing for Publication in Mathematics:
  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.SP.6	Summarize, represent and interpret data on two categorical and quantitative variables.	High School Statistics Task from *Writing for Publication in Mathematics* (featuring supports from YouCubed's Data Science Curriculum)

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 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.
Students use the statistical process to seek to understand the world around them, taking time to gain insights into data, looping back to make revisions to the question or data gathering if the results they

✓ MP.5. Use appropriate tools strategically.
Students informally determine whether a selected model is appropriate for a set of data and use technology when appropriate to do so.

have do not adequately address their question.

- ☐ MP.2. Reason abstractly and quantitatively.
- ✓ MP.3. Construct viable arguments and critique the reasoning of others.
  Students draw and discuss conclusions about a statistical question using appropriate mathematical models.
- ✓ MP.4. Model with mathematics.
  The four-step investigative process provides a structure for students to follow that allows them to model many real-world situations.
- ☐ MP.6. Attend to precision.
- ✓ MP.7. Look for and make use of structure.
  Students discover structures or patterns in data to answer statistical questions using tables or appropriate representations.
- ☐ MP.8. Look for and express regularity in repeated reasoning.

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.1, 3, 4, 5 and 7 felt like natural fits 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:
☐ Motivating students' learning of mathematics through opportunities for exploring and solving problems that build on and extend their current mathematical understanding.	✓ Persevering in exploring and reasoning through tasks. Students are supported in their exploration with the recommendation to use the Project Topic Brainstorm to identify who might be a part of your life, perhaps from your school (a specific teacher, coach, staff member, principal, athletic director, custodian) or in your community (city commissioners, parks and recreation, business owner, homeowners association, non-profit director) and would be willing to partner with you to influence to take action on the question you are exploring.
✓ Selecting tasks that provide multiple entry points through the use of varied tools and representations. This task has students driving the learning. As an example, the student is expected to initially, "Formulate a statistical question of interest to you that impacts you, your school or your community and can be answered with data."	☐ Taking responsibility for making sense of tasks by drawing on and making connections with their prior understanding and ideas.

Centering student interests and experiences provides multiple entry points and allows for student choice related to tools and representations in communicating about the data collected. ✓ Posing tasks on a regular basis that require a high level of cognitive demand. This task engages students in learning mathematics in a way that develops voice and perspective, allowing students to participate in an authentic context beyond the classroom more fully. Ideally, students make decisions about audience, purpose and/or form based on their interests, experiences or inquiry. ✓ Supporting students in exploring tasks without taking over student thinking. The task provides several examples that can be used as models for students across different areas, such as determining audience, considering purpose and selecting a mode of communication about the takeaways for the exploration. ☐ Encouraging students to use varied approaches and strategies to make sense of and solve tasks.	✓ Using tools and representations as needed to support their thinking and problem solving. Attention will need to be given to supporting students in telling the story of the data they investigated to their specific audience. One way to encourage audience awareness might be to have students create a slow reveal graph. The process of deconstructing their data visualization might encourage students to consider which specific details to highlight, how ideas are organized and how the information is relevant to themselves and to the audience. ☐ Accepting and expecting that their classmates will use a variety of solution approaches and that they will discuss and justify their strategies to one another.

How did we get here:

EMTP 2 feels like a natural fit for this data science activity as within this task students engage in the four-step investigative process for statistical reasoning outlined in the *KAS for Mathematics* – Formulating Questions, Collecting Data, Analyzing Data and Interpreting the Results.

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

- **Model good decision-making.** The four-step investigative process students experienced in middle school now provides a foundation for students as they continue to model increasingly complex real-world situations with mathematics (MP.4). Encourage students to reason inductively about data and make plausible mathematical arguments that take into account the context from which the data arose. When making mathematical models, students can use technology to visualize the results of varying assumptions, explore consequences, and compare predictions with data. Students justify their conclusions,

communicate them to others (orally and in writing) and critique the conclusions of others (MP.3). Students should also be aware of most common misinterpretations of correlation (KY.HS.SP.8) and should avoid suggesting strong statistical associations imply one causes the other.

- **Engage students in learning where they develop voice and perspective to more fully participate in the local context and beyond.** Look for opportunities to utilize primary source documents or lessons, such as graphs, situations, etc., that deal with current world events. Utilizing slow reveal graphs can be a powerful tool in creating curiosity, offering multiple entry points to a discussion on data and eliciting profound noticings from students. When learning to make a reasoned judgment after analyzing information, data, facts, encourage students to consider how making responsible decisions can promote systemic change within their local context and beyond.

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

What steps am I taking to establish a culture that reinforces with students that a mathematical model used to represent a problem's solution is a "work in progress" and may be revised as needed? Is there anything I might want to shift about my current approach?

Completing this task will mean students are engaging in an iterative process mirroring how data scientists work on a project. Students will gather their own data. They will make decisions about how to work with it and describe the choices they have made including what technology tools to use, cleaning moves, visualization selection, univariate or bivariate data choices, combining data, and other content relevant to their project of choice.

How might I study the community in which I teach and incorporate issues that affect my students into my instruction?

Students bring important knowledge, interests, and experiences from their daily lives to the classroom that teachers should elicit and use to inform instruction. An instructional technique called self-documentation is one way to do this. Educators who anticipate students having difficulty selecting a question to explore might consider engaging students in self-documentation prior to beginning the task. STEM Teaching Tools Practice Brief 31 provides support and examples of what this might look like. Moving forward, I would like to consider how to incorporate more of my community within what my class is exploring.

What steps am I taking to offer students opportunities to actively engage and use their voice within my classroom? Is there anything I might want to shift about my current approach? How might I support that same active engagement and voice beyond my classroom and beyond my school?

Students may need support identifying an authentic audience and purpose. The linked Project Topic Brainstorm above supports students in posing and answering a statistical question that is both of interest and may provide data to support changes in their school or community. As students explore a question of interest to them, the authentic audience may vary as well. Work with school leadership to determine data that students might collect to address school or community needs.

For support facilitating Writing for Publication at the end of this data science learning experience, consider accessing these slides from Unit 8 of YouCubed's Data Science curriculum on their process.

How did we get here:

As this task is grounded in student ownership, building on student and community interests and expertise is paramount. In supporting students with responsible decision-making, this task is a natural fit due to elements such as:

- demonstrating curiosity and open-mindedness;
- learning to make a reasoned judgment after analyzing information, data, facts;
- recognizing how critical thinking skills are useful both inside & outside of school; and
- reflecting on one's role to promote personal, family and community well-being.