Evidence-Based Instructional Practices

Explicit Teaching and Modeling and the Kentucky Academic Standards for Mathematics

The Explicit Teaching and Modeling Overview provides the research base associated with this evidence-based instructional practice.

What are connections between Evidenced-Based Instructional Practice #3: Explicit Teaching and Modeling and the *KAS for Mathematics*?

One strategic educator practice shown to improve the quality of day-to-day classroom instruction and significantly impact overall student achievement is **explicit teaching and modeling**. The *KAS for Mathematics* was purposefully designed to enhance the standards' clarity and function so Kentucky teachers would be better equipped to provide high quality mathematics for every student. The Clarifications support explicit teaching and modeling by providing examples and illustrations to communicate expectations clearly and concisely. Additionally, as "Modeling with Mathematics" is one of the Standards for Mathematical Practice (SMPs), the Attending to the SMPs component may provide guidance for explicitly teaching and modeling multiple mathematical representations. The use of explicit teaching and modeling strategies can support students in using (and making connections across) mathematical representations. The National Council for Teachers of Mathematics (2014) upholds, "Effective teaching of mathematics engages students in making connections among mathematical representations to deepen understanding of mathematics concepts and procedures and as tools for problem solving."

Modeling with Mathematics vs The Modeling Cycle
In the course of a student's mathematics education, the word "model" is used in a variety of ways. **Modeling with Mathematics** might include utilizing manipulatives, demonstration, role modeling and conceptual models of mathematics, all valuable tools for teaching and learning; however, these examples are different from participating in The Modeling Cycle. **The Modeling Cycle** (sometimes referred to as "mathematical modeling") is often pictured as a cycle, with a need to come back frequently to the beginning and make new assumptions to get closer to a usable result. **The focus within EBIP #3 will be on Modeling with Mathematics, not on The Modeling Cycle.** For more information on the Modeling Cycle see p. 8-10 of the *KAS for Mathematics*.

Educators planning to use explicit teaching and modeling strategies can support students in using (and making connections across) mathematical representations by allocating instructional time for students to use, discuss and make connections among representations and by encouraging students to use representations (pictures, symbols, verbal, real-life situations, physical models) in making sense of mathematics. (NCTM, 2014) As students engage in learning experiences that require them to listen to the argument of others, decide if they make sense and ask useful questions to clarify or improve the argument (MP.3), they gain a different perspective on mathematical relationships allowing them to approach mathematics in different ways and to apply mathematics more flexibly across situations they encounter in life. Using explicit teaching and modeling strategies to create these learning experiences contributes to supporting and sustaining a culture of equity and access across Kentucky.

What are planning considerations for the successful implementation of the Evidenced-Based Instructional Practice #3: Explicit Teaching and Modeling to ensure that all students have equitable access and opportunity to learn the standards contained in the *KAS for Mathematics*?

While strategies may vary, the following considerations from the Institute of Education Sciences What Works Clearinghouse provide guidance around how explicit teaching and modeling can support successful implementation of the *KAS for Mathematics*.

Utilize Think-Alouds to Model in Mathematics:
Thinking aloud is more than just the teacher telling students what he or she is doing; it also involves the teacher expressing his or her thoughts when approaching a problem, including what decisions he or she is making and why he or she is making each decision. Paying attention to structure can help students make connections among problems, solution strategies and representations (concrete, semi-concrete and abstract) that may initially appear different but are mathematically similar (MP.7). Students may need the teacher to model how to monitor and reflect by thinking aloud while solving a problem or by writing down the questions they ask themselves to clearly demonstrate the steps of their thinking processes. Consider:

- What potential strategies/representations might be valuable within the content I am teaching? How can I help students frame their thinking about these strategies/representations within my instruction? What similarities and differences do I want students to notice across the strategies/representations?
- What elements of my reasoning are important to articulate when making connections between problem and the strategy/representation?
- When misconceptions arise in the lesson, what instructional moves will I use (such as Talk Moves) to support students in clarifying and advancing their thinking?
- How do I demonstrate monitoring and reflecting on my problem-solving process within my instruction? Is there anything I might want to shift about my approach?
- What opportunities for student reflection are embedded within my plan for instruction? Are there specific reflection prompts that lend themselves to this learning experience?

Utilizing think alouds to model in mathematics offers opportunities for educators to integrate the content and practices by asking students questions, such as:

- How would you describe this problem using precise mathematical language? (MP.3, 6)
- Is this problem structured similarly to another problem you've seen before? (MP.1, 8)
- What strategy/representation is appropriate for solving this problem, and why? (MP.1, 2, 5)
- What choices or assumptions did you make in solving this problem? (MP.1, 8)
- How did you get your answer? How do you know it is correct? (MP.1, 3, 4, 6, 8)
- Did you run into any challenges? If so, how did you overcome them? (MP.1, 3)

Utilize Worked Examples to Model Strategies in Mathematics:
Worked examples can demonstrate how the same problem could be solved with different strategies and how different problems could be solved with the same strategy. The use of incomplete or incorrect worked examples may encourage students to confront their own potential errors in a non-threatening

way. Students may be more open and honest when evaluating hypothetical work than they might be if critiquing their own work. Including different types of errors can help students develop persistence by demonstrating problems are not always solved easily the first time and sometimes more than one strategy will need to be tried to solve a problem (MP.1). Consider:

- How might I select worked examples to elevate various mathematical representations or attend to varying levels of [cognitive complexity](#) within the content I teach?
- How might I want to structure student engagement with the worked examples? For example:
    - Alternating problems to solve with worked examples has been shown to help motivate students to pay more attention as it helps students prepare for the next problem.
    - Utilizing multiple examples simultaneously may encourage students to recognize patterns or make comparisons between the strategies.
- How might I address common misconceptions/preconceptions related to the content I teach using worked examples? Would I (or my team/PLC) benefit from examining the *KAS for Mathematics* more deeply using the [Breaking Down a Standard protocol](#) to reflect on common preconceptions, misconceptions and challenges/confusions that might arise for my students?

Utilizing worked examples to compare strategies in mathematics offers opportunities for educators to integrate the content and practices by asking students questions, such as:

- Which strategies/representations would be useful to solve the problem? Why would you choose this approach? (MP.1, 2, 5)
- Will _'s strategy/representation always work? Is there another reasonable strategy/representation? (MP.1, 2)
- _'s solved the problem differently, but the answer is the same. How is that possible? (MP.1, 2)
- How are the strategies/representations similar? How are they different? What can using a _ show us that _ may not? (MP.1, 5)

Utilize Prompting to Scaffold in Mathematics:

Once students are introduced to different strategies, prompting can help them develop skills for selecting which strategy to use. Teacher prompting or questioning may help students attend to and remember the connections between prior learning and the current mathematics they are doing. The prompts teacher use may vary depending on the purpose of the instruction and where students are in the learning process. Consider:

- What mathematical representations/strategies are included within the *KAS for Mathematics* for the content I am teaching? How might I support students in making connections among the representations/strategies?
- How deep is my understanding of how the mathematics content standards are connected within and across grade levels? What insights might I gain from the Coherence/Vertical Alignment within the *KAS for Mathematics?* How might I support students in finding connections between current and prior learning?
- How might I support students in working through problems without taking the thinking away from them? Are there prompts I could model within my instruction (and capture for students to use independently or in small groups) to aid in the problem-solving process? Might the discussion and analysis of worked examples (or work samples) offer an opportunity to capture student generated descriptions of the steps taken to solve the problem and explanations of the reasoning used?

Utilizing prompting to scaffold in mathematics offers opportunities for educators to integrate the content and practices by asking students questions, such as:

- What is the relevant information in this problem? Why is this information relevant? (MP.1, 4, 7)
- What strategy/representation could I use to solve this problem? (MP.1, 2)
- Why did you choose this strategy/representation to solve this problem? (MP.2, 3, 5)
- What were the steps involved in solving the problem? Would the steps work in a different order? (MP.2, 6, 7)
- Will this strategy/representation always work? Why? What are other problems for which this strategy/representation will work? (MP.1, 2, 8)
- What other mathematical ideas connect to this solution? (MP.4, 7)

What strategies and resources can support the implementation of Evidence-Based Instructional Practice #3: Explicit Teaching and Modeling within the *KAS for Mathematics?*

The *KAS for Mathematics*

There are many implementation supports found within the *KAS for Mathematics.* The standards intentionally integrate content and practices in such a way that every Kentucky student will benefit mathematically. The architecture of the K-12 standards has an overall structure that emphasizes essential ideas or conceptual categories in mathematics. Clarifications are included to communicate expectations more clearly and concisely to teachers, parents, students and stakeholders through examples and illustrations. To emphasize the cohesiveness of the K-12 standards, the coherence indicates mathematics connections within and across grade levels.

The Getting to Know the *Kentucky Academic Standards (KAS) for Mathematics* Module provides a deep dive into the architecture and implementation supports within the *KAS* by taking an in-depth look at components, such as the Standards for Mathematical Practice, Standards for Mathematical Content, Clarifications and Coherence. Included are a Facilitator's Guide that provides suggested activities to prompt meaningful investigation of the *KAS for Mathematics*. Additional resources needed to engage with this module are the accompanying PowerPoint and Module at a Glance.

The KDE's *Engaging the SMPs: Look Fors & Questions Stems*

Intentionally integrating opportunities for students to engage with the Standards for Mathematical Practices (SMPs) is critical to facilitating student growth in mathematical maturity and expertise throughout the elementary, middle and high school years. To supplement the *KAS for Mathematics,* the Engaging the SMPs resource provides guidance for teachers, including Student Look-fors, Teacher Look-fors and potential Questions Stems that promote student engagement in the SMPs.

The National Council for Teachers of Mathematics' (NCTM) *Effective Mathematics Teaching Practices*

NCTM's landmark publication *Principles to Actions* connects research with practice. The teaching of mathematics is complex. Utilizing this resource can support teachers in engaging students in making connections among mathematical representations to deepen understanding of mathematics concepts and procedures and as tools for problem solving.

The Institute of Education Sciences What Works Clearinghouse Practice Guides:

The Practice Guides below provide evidence-based recommendations for integrating explicit teaching and modeling within mathematics instruction. The following provide recommendations around modeling precise vocabulary during think-alouds, utilizing worked examples to advance student thinking and how prompting can support students in monitoring and reflecting on the problem-solving process.

While the guides indicate specific grade bands, the recommendations can apply across grade levels with appropriate modifications.

- *Assisting Students Struggling with Mathematics: Intervention in the Elementary Grades*
- *Teaching Strategies for Improving Algebra Knowledge in Middle and High School Students*
- *Improving Mathematical Problem Solving in Grades 4 Through 8*