Evidence-Based Instructional Practices

Questioning and the Kentucky Academic Standards for Science

The Questioning Overview provides the research base associated with this evidence-based instructional practice.

What are connections between the Evidenced-Based Instructional Practice #5: Questioning and the *KAS for Science*?

The *Kentucky Academic Standards for Science* identify what students should be able to demonstrate by the end of grade-level or grade-band instruction. The standards, written as performance expectations (PEs), are an integration of three different dimensions: disciplinary core ideas (DCIs), science and engineering practices (SEPs) and crosscutting concepts (CCCs). The DCIs are the conceptual content understanding of which students should have knowledge. The SEPs and CCCs are the dimensions that are used in service of the DCIs as students come to the conceptual understandings as they experience and actively engage with the sciences.

Teachers are accustomed to asking questions that will elicit existing knowledge, gain insight into student understanding of concepts and challenge student thinking of ideas. These *pedagogical questions* are often used in a formative fashion in that teachers are determining the direction, or next steps, in instruction. While often formed during the course of instruction, teachers should generate intentional questions related to the core ideas.

While pedagogical questions are important, student-developed questions, driven by phenomena to be explored or problems to be solved, are essential in developing scientific habits of mind. Having "the ability to ask well-defined questions is an important component of science literacy, helping to make [individuals] critical consumers of scientific knowledge" (*Framework for K-12 Science Education,* p.54). It is the phenomenon **plus** the student-generated questions about it that guide the learning and teaching.

Science is figuring out the natural and designed world. This figuring out, or sensemaking, should be a partnership between teacher and student and begins with a question. The question may be based upon a wondering, an observation or a thought about the phenomenon. But to get to the sensemaking, that question, or series of questions, should generate empirical data, which may be either qualitative or quantitative. As data are collected, analyzed and interpreted, more questions may arise that will lead to a deeper understanding of the concepts that will aide in the understanding of the phenomenon. This is the essence of the SEP of asking questions. Asking questions in order to understand and explain a phenomenon helps students figure out the important aspects that need to be explained. More questions are generated in order to “fill in the gaps” between what is known or discovered and what is still left to be figured out, thus guiding the next steps of the investigation.

As SEPs are used in service of understanding DCIs, asking questions is used in service of understanding core ideas associated with the phenomenon. They are a starting point towards understanding science, but they don’t stop there. Investigative, or research, questions lead to investigative planning, which ultimately lead to the development of models, explanations and/or arguments about the phenomenon. But, through the course of the investigation, more questions leading to further investigation can be formulated. In addition, as students engage with one another or offer critiques of peer scientific arguments, the posed questions will contribute to deeper understanding of the concepts related to the phenomenon.

What are planning considerations for the successful implementation of the Evidenced-Based Instructional Practice #5: Questioning to ensure that all students have equitable access and opportunity to learn the standards contained in the *KAS for Science?*

- Pedagogical questions should be intentionally developed
    - What are the core ideas associated with the phenomenon being studied or the problem being solved?
    - What are some potential misconceptions that are associated with the science ideas of which the unit is focused? What questions should be asked to bring these to the forefront in order to understand current student thinking about these understandings?
    - Where are the specific “hinge points” in the lesson(s) where it is important to gauge understanding before moving forward?

- Provide opportunities for student-developed questions
    - What is the anchoring phenomenon that will drive instruction throughout the unit? Will you and/or the students develop a focus question associated with this anchoring phenomenon?
    - How will you engage students in generating their own questions about the anchoring phenomenon?
    - What tools, such as a driving question board, may be used to organize student questions?
    - How will you provide opportunities for students to investigate questions that have been generated?
    - What opportunities will you provide for students to engage in peer-to-peer discussion, questioning and critique?

What strategies and resources can support the implementation of Evidence-Based Instructional Practice #5: Questioning within the *KAS for Science?*

- For information about developing a classroom climate conducive for questioning, see the Kentucky Department of Education (KDE) resource EBIP 1: Establishing the Learning Environment
- Science discourse and questioning are intertwined. For information about discussion in the science classroom, see the KDE resource EBIP 4: Discussion.
- The NSTA column Methods and Strategies: Ask the Right Question describes a method for helping students become confident in responding to and asking rigorous questions using literature. This article is written specifically for elementary teachers.
- Student and Teacher Moves from Doing and Talking Math and Science provides sample questions teachers may ask for various purposes.
- How Does the Driving Question Board Promote the Shift from "Learning It" to "Figuring It Out" is a presentation presented by Activate Learning. This presentation describes the use of a driving question board as students engage with the science and engineering practices as they work to understand and "figure out" phenomena.
- The STEMTeachingTools practice briefs provide further strategies in support of science discourse.
    - Practices should not stand alone: How to sequence practices in a cascade to support student investigations This practice brief describes the importance of intentional sequencing and intertwining of the science and engineering practices as students work to figure out phenomena.
    - Integrating Science Practices into Assessment Tasks This practice brief describes ways that questions can be asked for each of the SEPS as they are used in service of the DCI.
    - Prompts for Integrating Crosscutting Concepts into Assessment and Instruction This practice brief provides sentence systems for each of the crosscutting concepts as used in service of the SEPS and DCIs.
- Chapter 3 in the National Research Council (NRC) report *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*, Scientific and Engineering Practices provides a description of each of the SEPs including the practice of Asking Questions.
- Appendix F: Science and Engineering Practices contains characteristics of each of the SEPs, including Asking Questions, at the K-2, 3-5, 6-8 and 9-12 levels.
- There are numerous books and websites which describe common misunderstandings that students hold. One such website, Understanding Science, has compiled a list of common misconceptions about the nature of science and their corrections.