Science and Engineering Practice: Asking Questions

The purpose of this video is to provide students with an example of how a scientist asks questions to plan and refine their investigations. It is a resource to work directly with the one of the Science and Engineering Practices identified in the Next Generation Science Standards (NGSS). Understanding how a working scientist asks questions will prepare students to ask their own scientific questions as they investigate new phenomena or design investigations. This video can be accessed at: https://www.youtube.com/watch?v=ZuatRphalD8

Expected Outcomes: After working with this video, students will understand the purpose of scientific questions and begin asking scientific questions that can be answered using evidence.

Guide:

1. Before watching the video, gather students' ideas about how a question in science is different from other questions. Why does a scientist ask questions?

2. Explain that we will watch a video about a scientist who asks lots of questions. Explain that you will watch the video all the way through, and then watch it again to focus on specific parts

3. Watch the video all the way through.

4. Lead a brief discussion with students to clarify the purpose of Chong's research: She wants to learn more about how medications might help organisms stay healthy and active for longer. She found one medication, ibuprofen, which helps old worms move more than old worms that didn't get the medication.

5. Watch the video again. This time, ask students to take notes on the questions Chong asks and the purpose of the questions. It might be helpful to pause at each question to give students time to write their thoughts.

6. Debrief the video by developing a class list of Chong's questions (summarized below). You can assign groups of students to discuss one of the questions and report back to the group (Practice 8: Obtaining, evaluating, and communicating information). Why is

this question is a scientific question, and how it can help Chong with her research goal? How could she design an experiment to find an answer to her question?

a. Does ibuprofen definitely cause the effect of more movement in old worms?
b. Is there a dose that matters (does more ibuprofen lead to more movement)?
c. Does ibuprofen make muscles work better?
d. Does ibuprofen make nerves work better?
e. Is there a relationship between inflammation and movement?
f. Does another anti-inflammation drug have the same effect of helping old worms move more?

Background Information on Asking Questions

Scientific questions are distinguished from others because they are empirically testable and can be answered using evidence. The questions a scientist asks, and the answers they seek, ultimately help to guide their investigations and experimental design.

Asking scientific questions involves more than just curiosity (though curiosity is essential!). The questions a scientist asks incorporate both their observations and what is already known about a topic. The purpose of asking questions can be to

- Distinguish what is known from what is unknown
- Clarify the conditions and components of the system under study
- Probe for a causal (why) or mechanistic (how) explanation of a phenomenon

Followup: Have students practice asking their own scientific questions when they are introduced to a new phenomenon. This can be done as an individual written activity or as a class activity.

1. Students make observations about the phenomenon. What do they notice? What is unexpected or interesting? What parts can they explain, and what can they not yet explain?
2. Students identify what they already know about the phenomenon or topic.
3. Students brainstorm questions that would help them learn more.
4. Working in partners, students can critique and refine their questions. They can use the following criteria to establish good scientific questions:
    a. I could gather data to answer this question
    b. Answering this question would help me learn more about my observations

c. Answering this question could help me plan an scientific investigation/experiment
d. Is there more than one way to interpret this question? Is it using specific language and/or defining testable measures (e.g. what does “best” or “healthiest” mean)?

Tips: Students can use crosscutting concepts as a lens to identify questions that:

- Separate **cause and effect** (e.g. Am I observing a cause, or an effect?)
- Compare a **system model** with a natural system (e.g. how is what I am observing different than it might appear in the natural world?)
- Probe conditions that yield **stability or change** (e.g. What conditions would change what I am observing? In what ways might it change?)