Lesson 5: Testable Questions

Materials
- One piece of white computer paper per group
- 4-5 post-its per student (depending on how many groups created)
- Markers
- Tape
- “SMART questions” print out - 1 per student

Overview
Testable questions can be answered by designing and conducting an investigation rather than looking them up online or in print. It is important that testable questions are developed from prior knowledge of the general topic area and of the datasets available. Therefore, providing time and support for this step is critical to setting students up for success. With the guideline of creating a “SMART” testable question, students will create and peer review their own testable questions based on the datasets provided.

Motivating Question: What influences biological hotspots at the Palmer Deep Canyon in Antarctica? How can we use testable questions to address this?

Take Home Message
- Students will develop testable scientific questions based on biotic and abiotic interactions at the Palmer Deep Canyon in Antarctica. This collaborative process will allow students to develop “SMART” testable questions and complete peer reviews on the scientific questions created by their classmates.

Engage: **Introduction to Asking Testable Questions** ● Class will be asked a vague question and provided the SMART guidelines. ● The class will work together to modify the question and make it SMART. (See Creating Testable Question Slides)	10 minutes
Explore: **Writing Testable Questions** ● Students will use their understanding of abiotic and biotic factors ● Students decide what factors they are interested in, and write a question in general about the relationship. ● Look at the data to see if that information exists, then go back to revise the question/make it SMART or create a new question if the data doesn't exist ● Using Post-It notes, students will provide feedback to their peers to help refine the SMARTness of the question. (referencing the SMART guidelines- one copy given to each student)	30 minutes
Make Sense: **Revising Questions Based on the SMART guidelines** ● Students will revise their questions based on student feedback to create	15 minutes

a final SMART question ● Students will participate in a final gallery walk to display their testable questions to their classmates.	
Total:	**55 minutes**

Audience

Middle and High School Students

Preparation

- Teachers should familiarize themselves with the SMART acronym and look at the examples of poor questions that have been rephrased to be testable. A slideshow has also been created for the teacher and should be reviewed.

Engage (10 minutes)

- Use the "L5 Testable Questions" PowerPoint. All points below can be found in the slides.
- Discuss the basic points of a testable question with the class.
  - Testable questions can't be looked up online or in print
  - Testable questions use datasets to answer the question being asked
- Have the students look at the example question, "How does water temperature change over time?"
  - Ask the class if this is a good question to guide research? Discuss why or why not. See feedback on given on "Creating a Testable Question" teacher sheet.

    TEACHER GUIDE: Guiding questions for the teacher to help prompt discussion for the example testable question.

    - Do you think there is a certain data set we can use to help answer this question? (no, the question is not specific to a location so that isn't possible)
    - How do you think the question could be more specific? (location, specific time frame with years, etc)
    - What should we add to the question to help make it more specific to what we have been studying in Antarctica?
- Present the students with the SMART guidelines and have them reassess the question based on those requirements. At this time you can give each student a copy of the SMART guidelines to keep.
  - Rewrite the question as a class to include the SMART guidelines. Discuss what needs to be included to make the question a SMART testable question.
- Show a few additional examples of these questions if necessary (examples on the "Creating a Testable Question" teacher sheet)

Explore (30 minutes)

- Students should be put into groups of 2-4 students based on their interest in the Antarctic information that has been given in the previous activities. The general interest topics for this project are gliders, HF radar, and penguins.
    - The students will be diving into these topics throughout the next couple of lessons. The teacher should allow groups to develop questions based on their interests with the Antarctic information that has been discussed.
    - The teacher can use their own preference on how to group students.
- Each group will produce one testable question about their topic. They should keep the SMART guidelines in mind as they create their question. As the teacher you are circulating around the room to guide student conversations.

  TEACHER GUIDE: If students are interested in more than one topic or comparing topics - that is possible! The students will need to pull information from two different data sets to make that happen.

- Students write their question on a sheet of printer paper with a marker and place it around the room with the tape.
- After all questions are posted, students move around the room (gallery walk) writing feedback to their peers on post-it notes. The post - it notes can be placed around the question.
    - The feedback from peers should address the SMART guidelines

<u>Make Sense</u> (15 minutes)

- After the gallery walk, students return to their testable question and read the feedback that they were given.
- The groups will revise the feedback to establish a good SMART question.
- If time allows, the revised questions can be posted again or read aloud to show the new SMART testable question for each group.

  TEACHER GUIDE: The questions will be revised again after looking at the data sets in the next lessons so they don't need to be finished or "perfected" at this point.

<u>Additional Information</u>

NGSS Standards

Middle School
MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

MS-LS2-3. Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.

MS-LS2-4. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

High School
HS-LS2-2. Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.

HS-LS2-6. Evaluate claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.

HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

Cross cutting concepts
Patterns
Cause and effect
Scale, proportion and quantity
Systems and system models
Energy and matter
Structure and function
Stability and change

Science and Engineering Practices
Asking questions and defining problems

Polar Literacy Principles Addressed
Polar Principle #4 - The Polar Regions have productive food webs.
Polar Principle #7 - New technologies, sensors and tools— as well as new applications of existing technologies—are expanding scientists' abilities to study the land, ice, ocean, atmosphere and living creatures of the Polar Regions.

Ocean Literacy Principles Addressed
Ocean Literacy Principle #5: The ocean supports a great diversity of life.

Climate Literacy Principles Addressed
Climate Literacy Principle #3: Life on Earth depends on, is shaped by, and affects climate.