canopy in the clouds
dosel en las nubes

SCIENCE AND HYPOTHESIS TESTING

Jennifer Reese, F.A. Day Middle School, Newtonville, MA

Grade Level: 6-8

Introduction: After reading background information on the cloud forest, perusing the panoramas, and watching video clips, students will compose a testable question that pertains to any aspect of the cloud forest. Students will then propose a hypothesis and design an experiment that would help answer the question. Students will work in pairs to discuss their questions, hypotheses, and experimental designs. [Note: This lesson is a sensible follow-up to *The Tools and Techniques of Field Work* lesson.]

Major Themes: Science as inquiry

Connections to National Science Education Standards: Identify questions that can be answered through scientific investigations (A); design and conduct a scientific investigation (A); recognize and analyze alternative explanations and predictions (A).

Time: 60 minutes (5 minutes for opening, 30 minutes for student handout, 20 minutes for peer conferencing, 5 minutes for closing)

Materials: Students will use an assortment of videos and other media on the *Canopy In The Clouds* website including the "Cloud Forest Introduction" and "Canopy Introduction" overviews on the student materials page.

Computers with internet access (at least one, preferably enough for one per pair of students)
LCD projector (recommended)
Interesting Information about the Cloud Forest (one copy, cut into strips)
Student handouts (*Foundations of Scientific Research, Foundations of Scientific Research: Peer Conferencing, Testable Questions*)
Loose leaf paper

Objectives: Students will be able to: (1) create a question that can be answered through a scientific investigation, (2) compose a hypothesis, (3) design a scientific investigation

Potential Misconceptions:

(1) Many students think that there is ONE scientific method, or series of rigid steps that a scientist must follow to conduct his/her research. While certain components of scientific investigation *are* indispensible, science does not always play out in a step-by-step fashion in real life. Instead, we use the term *inquiry method* to describe the more organic approach scientists take when conducting research.

(2) Often students think that there is a "right" or distinct answer that awaits a scientist at the end of his/her study. Students may be uncomfortable with the notion that scientists do not always know if they have arrived at a "right" answer, or any answer at all. More often than not, scientists have new data which may lead them to greater understanding about the natural world, but an answer is not certain.
(3) Data that is unexpected or that does not support the original hypothesis is not wrong, and does not necessarily mean that the researcher made mistakes in his/her data collection process.
(4) Questions suitable for scientific research are carefully crafted. Ill-defined questions do not lend themselves to the organized collection of quantitative or qualitative data, and thus cannot serve as the starting point for a meaningful scientific investigation.

PROCEDURE

Opening: As students enter the room, hand each a fact strip from the *Interesting Information about the Cloud Forest* sheet. Instruct students to read the sentence on the strip then share it with a neighbor (or with their group, depending on your seating arrangement). Solicit volunteers to read their sentence strips aloud to the entire class. Say to students, "This information is fascinating, but how do we know all of this about the cloud forest?" Encourage students to share their ideas about how this information came to be known. If no student mentions it, or to reinforce the idea after a student does mention it, explain that we know this information because of *scientific research*.

Development: Have students sit at a computer alone (or in pairs, depending on availability). If there is only one computer and it is connected to an LCD projector that will work as well. Distribute the *Foundations of Scientific Research* student handout. Solicit volunteers to read the handout aloud. Lock computer keyboards (if possible) to encourage attentiveness. Address any questions that students have about the handout or assignment.

After reading through the handout in its entirety, use the designated computer and LCD projector to guide students to the "Cloud Forest Introduction" and "Canopy Introduction" overviews on the student materials page. When students arrive at the appropriate page, they may begin working on their own to complete the handout.

As students are working, circulate around the room and stop to interact with every student (or pair) at least once. Ensure that students are on task, following the handout instructions appropriately. If the classroom space allows, have students move back to a desk so that they have a workspace more conducive to thoughtful reflection and writing. (Students may return to the panoramas (or other Canopy in the Clouds media) at any time during the lesson, but they should not spend the majority of their time doing so.)

As you check in with students, ask questions to encourage them to explain their ideas. For example, if a student gets stuck on the "I wonder" statements, ask him/her what was interesting or surprising in the Canopy in the Clouds text and panoramas. Offer an "I wonder" statement of your own for additional support. When reviewing students' research questions, ask them for specifics about their questions. For example, "What data would you collect?", "What do you mean by 'strong'?", "Do you mean *all* plants in the cloud forest, or just a particular species of plant?"

Notify students when they have about ten minutes of working time left before beginning the peer conferencing so that they can manage their time accordingly. When it is time for peer conferences, distribute the *Foundations of Scientific Research: Peer Conferencing* student handout. Pair up students and allow them to sit together to share their research questions, hypotheses, and study designs. Students should complete their peer conferencing handouts during the course of their conferences.

Closing: Ask students to reflect on the question-creating and study-designing processes. Share and address insights, frustrations, questions, and other comments about the activity.

Suggested Student Assessment: Assign the *Testable Questions* worksheet for homework. Students will create testable questions, identify independent and dependent variables, and compose related hypotheses on a variety of topics. The next class can begin with a discussion of this assignment. Allow time during this follow-up class to reteach and/or reinforce the important concepts from the day before, especially as student confusions arise.

Extending the Lesson: Students may conduct research (online, in the school library, by interviewing experts, etc.) to collect information relating to their research questions. This information can be shared with the class at a later date.

Vocabulary: inquiry method, testable question, independent variable, dependent variable, hypothesis

WORKSHEETS: *Designing and Conducting Scientific Research, Designing and Conducting Scientific Research: Peer Conferencing, Testable Questions*