canopy in the clouds
dosel en las nubes

MEASURING LIGHT IN THE CLOUD FOREST

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Grade Level: 6-8th

Introduction: Sunlight is an important resource in the tropical montane cloud forest of Monteverde, Costa Rica. Students will collect data on the quantity of sunlight penetrating different locations within the cloud forest and relate this data to the percentage of green plant growth observed. Students will also have an opportunity to study a light gap within the forest, comparing the information they previously gathered with this important site.

Major Themes: Ecosystems, sunlight and plant growth

Connections to the National Science Standards: Populations and ecosystems, Scientific inquiry

Time: 45 minutes (5 min for opening discussion, 10 min for initial observations and directions, 15 min for Understory & Canopy data collection and analysis, 10 min for Light Gap data, 5 min for closing)

Materials: One computer with internet access for each student group, computer with internet access and LCD projector for teacher, measurement squares copied on clear transparences. *Canopy In The Clouds* Panoramas #2 & 7. Student handouts included.

Objectives: Students will be able to 1) make observations about sunlight availability within the cloud forest 2) predict the impact of sunlight availability on plant growth 3) collect data and create conclusions regarding the relationship between sunlight availability and plant growth in the cloud forest.

Potential Misconceptions: Students may have the following misconceptions:

1) Some students may believe that sunlight makes plants grow. However, plant growth requires more than just sunlight. Clarify for students that sunlight is a crucial stimulus for photosynthesis, a process by which plants build sugars. The sugars then allow tissues within the plant, known as meristem, to divide and grow. Increased amounts of sunlight do stimulate more photosynthesis to occur, as long as sufficient amounts of water, carbon dioxide, and soil nutrients are available. Sunlight alone cannot make a plant grow.

PROCEDURE

Opening: Darken the classroom as much as is possible, safely, before students enter. When they arrive, ask students to answer the following questions on a piece of paper:

- What role does sunlight play in your life?
- How does the presence of sunlight make life easier?

- How does the presence of sunlight make life more difficult?
- How did sunlight impact your ability to complete this task?

Have students share their answers with the class. Discuss their opinions regarding the role and importance of sunlight in their own lives, as well as the environment they live in. Explain that students will be studying the availability of sunlight within a tropical montane cloud forest in Monteverde, Costa Rica and its impact on the plant growth in that ecosystem.

Development: Pass out the student handout *Quantity of Light and Plant Growth* (p.1). Explain to students that they will be looking at the understory *(a layer of small trees, shrubs and saplings that occur below the canopy)* and the canopy *(the uppermost layer of vegetation formed by the crowns of trees in a forestwithin the same cloud forest location)* of a cloud forest. Review terminology if necessary. Display Panorama #2, Hotspot #4 "Light in the Forest" and Panorama #2, Canopy Hotspot #1 "Light in the Canopy". In the observation section of the handout, ask students to record the amount of sunlight penetrating the understory and canopy.

Write the scientific question on the board: How does the amount of sunlight available affect plant growth in the cloud forest? Ask students to create a hypothesis for this question. Encourage students to utilize the format "I predict….because…." or "If…then…because" while writing hypotheses to ensure their prediction is based on observations. For example: "I predict that more sunlight will lead to more plant growth because sunlight is an essential component of photosynthesis."

Provide each student with one measurement square. These are included on p.6 of the student handouts (*Measurement Squares*) and should be copied on clear transparency sheets and then cut out. Measurement squares are 2cm on each side, and have been subdivided into four smaller squares. Students will be placing these squares on different locations within the *Natural Scene Panoramas* and determining the percentage of the square filled with plant growth. Carefully discuss the procedure steps with the students (p.1 of student handouts) and then allow them to collect data in partners.

As students are collecting data, walk around to ensure that they are using the natural scene panorama and choosing locations that will lead to unbiased, scientific data. Students should not place their measurement squares on areas of the panorama that include large areas of blue sky or on tree trunks that are in close proximity. Trunks covered in epiphytes are appropriate to use in data collection, as are locations on the ground. Encourage students to choose locations within the panorama as randomly as possible, and not to "select" locations that will better support their hypothesis.

Once data has been collected for the understory and canopy, allow students to exchange their information with other groups and calculate the average percentage of coverage for the understory and canopy. Ask students to create a graph of their data for easier comparisons. A blank graph is available on p.3 of the student handouts for students to use as a template. Instruct students to create a bar graph with percentage increasing in increments of 5 along the y-axis. The x-axis will not have numbered increments, but three locations instead: "Understory," "Canopy," and "Light Gap."

Students should then write a conclusion that answers the scientific question. Reassure students that developing a conclusion that is different from the original hypothesis created is acceptable. Encourage them to support their conclusion with data collected from the *Canopy In The Clouds* panoramas.

Now, explain to students that they are going to collect data on one more location within the cloud forest, a light gap. Display Panorama #7, Hotspot #1 "Site Introduction" for students and ask them to describe what a light gap is on the *Light Gap* handout (p. 5). The teacher may want to pause the video after 15 seconds, to prevent hinting at information that will be developed later in the lesson. Follow the same procedure for collecting, exchanging, and calculating data using the natural scene of panorama #7. Students should add the data to the graph they completed for the understory and canopy of Panorama #2.

Closing: Since the exact quantity of sunlight available in the light gap is not provided, ask students to answer the following questions. They may add the answers to the conclusions they wrote earlier.

- Using previous data collected, write a hypothesis for the quantity of sunlight in the light gap. "I predict that the light gap has…. units of sunlight because…"
- How does the predicted amount of sunlight in the light gap compare to the sunlight in the understory and canopy locations?
- How is the light gap location similar to or different from the mid elevation location of the cloud forest?
- What is the role of sunlight in the cloud forest ecosystem? Why is it important?
- How do you think the quantity of sunlight reaching an area impacts the amount of plant growth? Explain your answer using information gathered during this lesson.

If time permits, have students share their answers with the class. Record their predictions for quantity of sunlight in the light gap on the board and discuss the data that each one used to create this hypothesis.

Suggested Student Assessment: Students can complete p.7 of the student handouts (*Student Assessment ~ High Elevation*) in which they examine the understory at the high elevation cloud forest site. Students must use the data they collected regarding plant growth coverage to make a prediction the amount of sunlight reaching this part of the forest.

Extending the Lesson: Set up a classroom experiment in which seedlings are grown in full sunlight and minimal sunlight. Control all other variables, such as ambient temperature, volume and timing of water added, quality of soil, and type and quantity of seeds planted. Chart the growth of the plants over several weeks and have students analyze the results. Determine the impact of sunlight availability on plant growth within the classroom.

Vocabulary: understory, canopy, light gap