LIGHT AND SHADOWS IN THE CLOUD FOREST
Erin Dukeshire, Academy of the Pacific Rim, Hyde Park, MA

Grade Level: 5th

Introduction: Students will be describing their conceptions of light and shadow in the context of the cloud forest. After sharing their initial understandings, they will observe light and shadow in panoramas from the Monteverde cloud forest. Through discussion and the use of photographic evidence, students will enrich their understanding of light movement. They will arrive at a correct explanation for how shadows form, and they will begin to develop an understanding of how plants use light.

Note: An introduction to the cloud forest and the panoramas will be necessary if students are not already familiar with the panoramas.

Major Themes: Ecosystems, Energy, and Scientific Inquiry

Connections to the National Science Standards:

Transfer of Energy: Light interacts with matter by transmission (including refraction), absorption, or scattering (including reflection). To see an object, light from that object-- emitted by or scattered from it-- must enter the eye.

Populations and Ecoystems: For ecosystems, the major source of energy is sunlight. Energy entering ecosystems as sunlight is transferred by producers into chemical energy through photosynthesis. That energy then passes from organisms to organism in food webs.

Scientific Inquiry: Use appropriate tools and techniques to gather, analyze, and interpret data.

Time: 1 hour.

Materials Required: This activity can be achieved using a variety of panoramas. It may be especially effective to have students compare an understory panorama, a canopy panorama and a panorama from either the light gap or the pasture. Computers with internet access. The exercise can be completed with a single computer with access using an LCD projector. Students can be called up to "navigate" through the panoramas. Student handouts are all included in an associated package.

Objectives: Students will be able to 1) describe their prior knowledge about light and shadows, 2) describe their prior knowledge about how plants interact with light, 3) explain that shadows form when light is blocked and 4) analyze qualitative data to determine the nature of moving light.

Potential Misunderstandings: Notably, students may have the following misconceptions:

1) Students may think that plants in the canopy receive more light because they are closer to the sun.
2) Students recognize *reflection* as a term that relates to light, however, they will attempt to use it to explain unrelated concepts.
3) Students may have vague notions of shadows. Some will describe them as shapes, without understanding why they form. Others will relate shadows to light, but be unable to determine the precise relationship.
4) Students may not know that leaves absorb light. Some students discuss how leaves shine or change color when light hits them. Few recognize that leaves absorb light before this concept is taught.

PROCEDURE

Opening: Have students write down things they know about light. After sharing with a partner, have students share with the class. Record their ideas on the board in order to refer back to them. Tell students that they will be sharing their understanding of light and explaining why shadows form. They will be observing interactive panoramas from the Monteverde cloud forest in order to determine how light moves and how shadows are formed.

Development: Project a panorama for students to view. Scroll around the forest while students draw and record observations of anything they see on page 1 of the handouts (*Data Sheet*). Next, remind students that they will be focusing on the movement of light. Instruct them to observe the panorama again, this time adding detailed observations about light in the cloud forest. Where is it light? Where is it dark? Here you may choose to use an additional panorama to provide contrasting views of the forest.

Tell students to share their observations about light with a partner. Then students should share out with the class. Record their observations on the board in order to refer back to them.

Ask students: Why do you think some places are dark and other places are light? Encourage students to share their ideas and explain their thinking. Prompt students to respond to each other. As they mention vocabulary words that relate to light, record the words on the board and ask students to define them. Encourage students to refer back to their observations of the panorama as they share.

As the discussion continues, ask the following questions to draw out students' beliefs about light and shadows:
> Where does the light come from?
> Does light move? How?
> Where does the light go?
> Why does less light reach the forest floor than the canopy?
> Why doesn't light just go around the leaves at the top of the forest?
> Do plants do anything with light? What?

Closing: Refer back to students' initial ideas about light. Ask students what they would like to add, change, or erase from the list. It is not necessary to correct all misunderstandings, but it is important to acknowledge that during upcoming lessons, the class will investigate their current ideas and evaluate them again.

Suggested Student Assessment: Students complete an assessment of short-answer questions on page 2 of the handout (*Assessment*). They must explain their thinking using evidence from the panoramas. They should use appropriate vocabulary to discuss light. Their work should identify that shadows and darkness occur because of an absence of light.

Extending the Lesson: Allow students to investigate how plants grow in different light environments. Set up two plants in the classroom. Grow one under a halogen light and the other with very little light. Make regular observations to determine which plant grows faster and taller. This experiment works well with corn or tomato seedlings.

Vocabulary: absorb, light, shadow and other general vocabulary as necessary from the glossary.