Hickory Dickory Dock: The Biological Clock Lesson Plan

Overview

Animals use a number of different cues to determine when it is time to migrate. In this lesson, students will investigate the effect of day length, or photoperiod, on animal migrations, and make additional connections between their own biological cues (e.g. feeling hungry) and migration cues of animals.

Suggested Lesson Sequence	Please see Migrations del Mundo and Seasonal Changes module descriptions.
Lesson Level	Intermediate
Science Connections	· Students will investigate how the **day length** (**photoperiod**) changes seasonally, and that this change can trigger biological actions in animals. · Students will discriminate between **natural** and **human-made** cues that trigger their own movements. · Students will make the connection between their own **cues for movement** and those cues used by animals to start their own movements and migrations.
Mathematics Connections	· Students will **calculate** the amount of **time** that elapses between sunrise and sunset using manual and computer methods. · In working to **subtract** and **add** time, students will become more familiar with working in **alternate base numerical systems** (i.e. 60 minutes equal one hour).
Technology Connections	· Students will use the **Internet** to find the **photoperiod** of their home town and determine the **sunrise and sunset times** for days in each of the four seasons.
Lesson Assessment Tools	Assessment and Standards Table (Word) Assessment Activity Description Authentic Assessment

Materials

This lesson requires Powerpoint Reader (Windows / Mac), and Quicktime Player.
Photoperiod Activity Sheet—one copy per student
Computer with Internet connection
Weather section of the local newspaper
Hickory Dickory Dock movie (Quicktime), starring Pixel the Satellite
Biological Clock Interactive Slideshow (Powerpoint)
Biological Clock Assessment Slideshow (Powerpoint)

About the slideshows: These slideshows are not meant for students to read through on their own. They are intended to be viewed together, to outline and illustrate a discussion of the lesson's themes, led by the teacher. You might have a different student read each slide's text.

Vocabulary

Biological clock: A function inside the body of any living thing which controls biological rhythms (patterns) such as sleep, migration, reproduction, and other changes.
Photoperiod: The amount of time that some amount of light occurs over the course of a day.

Vocabulary Note: students will likely be unfamiliar with other vocabulary presented in this lesson. This is done intentionally, to spur additional conversations and discussion about these words and their meanings. Encourage your students to ask about words they may be unfamiliar with.

I. Assessing Prior Knowledge

In the Nomad Land lesson, students recorded their migrations for one day. Ask the students to review their list of migrations and ponder the question, "how did you know when to begin your migrations?" Possible answers include the sounding of a bell, a teacher's instruction, and the time on the clock. If students also recorded their migrations at home, such as on a weekend, you may want to discuss the migrational cues they follow at home, such as getting up out of bed when the sun is shining in their eyes. ***Note:*** *if you have not yet done the Nomad Land lesson, you may just compile a simple list with your students of the places that they go over the course of a day and the reasons their bodies need to go to these places (e.g. to eat, get a drink of water, play, use the restroom, etc.).*

After students have brainstormed possible reasons for their "migrations," ask them to think about the world of an animal. Animals do not have bells or classroom teachers telling them when to migrate. So then how do animals know when to migrate? Students should think about their own migrations outside of school and their observations of animals to brainstorm answers to this question. The responses may be recorded on the chalkboard or overhead for

later review.

II. Contextual Preparation

Ask the students to imagine that they no longer have clocks, bells, or teachers telling them when to migrate. Looking at their list of migrations, which activities might have biological or environmental cues that could help them decide when to move? Which do not? What are some of these biological or environmental cues? (Examples of this could be that it is time to go to recess when they are feeling jittery or tired, going to lunch when they are hungry, and falling asleep when it is dark or they are tired. In contrast, they may say that going to periods for math or music has no such cues, except that they have simply come to expect that it is time for these activities.)

To further set the stage for this lesson, view the Biological Clock animated movie narrated by Pixel the Satellite. The transcript for this animation is provided below, for you and your students' use:

(Pixel is listening to a clock ticking in outer space) 1. "Time is *so* interesting! 'Time for dinner! Time for bed!' You probably know *these* times very well. People tell time by using watches, clocks, and calendars. Animals need to know when to eat and sleep, too. But how does an animal tell time without having a watch, clock, or calendar to read? There are many secrets of nature that animals use to tell time using what is called the "Biological Clock". And you know what? People have biological clocks too. What is a biological clock used for? And, how can you learn to read your own biological clock? You'll learn all about this with your teacher in the next lesson. In the mean time, I'm late for a meteor shower! See you soo-oon!"

III. Student Activities

1. Background information for the teacher: Some animals make long migrations during certain periods of the year, such as the Swainson's hawk or green sea turtles studied in the lesson . How exactly do these animals know when to migrate? *Migrational cues* can come from a variety of sources. One very important such cue is the length of the day. As the seasons change, the length of the sunlit day, called the *photoperiod*, also changes. In fact, scientists have learned that day length (photoperiod) is one of the most critical factors controlling the biological clock of animals.

2. View the Biological Clock Interactive Slide Show now with your students. Students learn about the connection between the sun, photoperiod, and animal functions in this slide show. Take the time to point out the recurring themes in this slide show, including points such as animal functions, seasons, and day length. By the end of the slide show, students should be able to recognize the importance of day length (photoperiod) in animals' lives.

3. Ask the students to hypothesize about which seasons, or even which days, have the longest photoperiods (spring and summer) and which have the shortest (autumn and winter). How

can we test our hypotheses? Is it possible to measure the photoperiod of a day? How could a student do this on her/his own? *(They could measure the time from sun-up to sun-down).*

4. Using information from the weather section of that day's local newspaper, write the times of sunrise and sunset on the board. Calculate with your students the time between sunrise and sunset using any hour/minute counting method. First, you might count the hours, then add the remaining minutes. For example, if sunrise occurs at 6:43 a.m. and sunset occurs at 5:52 p.m., you might count whole hours ending with :43 (e.g. 7:43am, 8:43am, etc. until reaching 5:43pm, and then add the extra 9 minutes to your total to arrive at the answer of 11 hours, 9 minutes). As an alternative, you might first point out that there are 17 minutes between 6:43am and 7:00am, then count whole hours until 5:00pm, then add the remaining 52 minutes. This method would reveal an answer of 10 hours, 69 minutes. Using both methods will help students to become more familiar working with a "base-60" system (60 minutes equaling one hour). At this time, you might also introduce the concept of "24-hour", or "military" time, whereby 1:00pm is written as 13:00, etc. Students will learn that using "24-hour" time simplifies time calculations when the time period spans the noon hour.
5. Hand out the Photoperiod Activity Sheet. Students will repeat the manual time calculation exercise described above on their own.

6. From the above calculations, students will now know the photoperiod of one day, but how does the photoperiod of your home town change over time? One way for students to calculate the way photoperiods of their town change over time is to visit the web site: http://aa.usno.navy.mil/data/docs/RS_OneDay.html

   Using the same Photoperiod Activity Sheet, students will test their hypothesis about which seasons have the longest or shortest photoperiods. Students should choose days from within each of the four seasons. Students may need assistance calculating the length of the photoperiod or the time elapsed from sunrise to sunset. Concrete manipulatives such as an actual clock could be helpful. When the photoperiods are calculated, write them on the activity sheet. Ask children: Would you have to wake up earlier or later to measure the start of the photoperiod in the summer, compared to in the winter? *(Earlier)*

7. Referring to their data, students should answer these questions:
   What season has the longest day? *(The Spring/Summer transition, also called the summer solstice.)* What season has the shortest day? *(The fall/winter transition, also called the winter solstice.)* When do you think the days begin to get longer? *(Although the shortest day the winter is Dec. 21 (winter solstice), they begin to get longer after this date. This may not be evident unless children collect more photoperiod data over time.)* When do days begin to get shorter? *(Although June 21 (summer solstice) is the longest day, the days begin to get shorter after this date in the Northern Hemisphere).*

8. Have students remember back to some of the reasons animals migrate (reproduction,

availability of food, temperature changes). Just as animals do not have classroom clocks, they also do not have calendars. How might photoperiods help animals know what time of the year it is? Scientists believe that photoperiods serve as a type of "early warning signal" to tell of upcoming changes in climate or food availability. These signals trigger long-range migratory animals to produce special hormones in their bodies. After the hormones are produced, the animal begins to ready itself for the upcoming migration by eating large amounts to produce fat stores. Then, environmental cues such as food scarcity or cold temperatures may be the final push to send the animal on its migratory path. Importantly, these hormonal changes *do not occur* in non-migratory animals!

Internal changes in animals are often triggered by changes in the photoperiod. These internal (physiological) changes can arise due to changes in hormones or other internal concentrations. The rhythmic internal changes that do take place within animals regularly on a recurring basis (whether season to season, such as with long-range migrations, or day-to-day, such as with nomadic migrations and other behaviors) constitute what is called an animal's *biological clock.*

Questions for Class Discussion:

1. Do humans have a biological clock? Does this biological clock tell humans to sleep in the daytime or in the nighttime? Does this biological clock tell humans to migrate long distances every year, like the hawk or hummingbird?

   Humans do have internal biological clocks. Examples are feelings of hunger or waking up without alarm clocks. Some nomadic humans migrate and follow migrating animals/food sources during seasonal changes, but it is not known as to whether these human migrations are linked to the human biological clock.

2. When is the photoperiod longest? When is it the shortest?

   Photoperiod is longer in the summer (because the Northern Hemisphere is tilted toward the sun and thus receives more light). In the winter photoperiod is shorter (because the Northern Hemisphere earth is titled away from the sun).

3. Why is photoperiod important to migratory animals?

   Photoperiod is a migrational cue for animals to begin migrations. (see explanation in Activity step #8)

4. How is the photoperiod different from an animal's biological clock?

   Photoperiod is an external cue that triggers internal physiological changes in an animal, such hormonal changes. These internal changes that occur regularly constitute an animal's

biological clock.

5. Which cues for a student's movements over the course of a day are natural, and which are human-made? How do these cues relate to the migrational cues of an animal?

   Cues such as getting out of bed when the sun is out is a natural cue. Cues such as bells or alarm clocks are human-made. The photoperiod is a natural cue that affects the migration and some other functions of animals.

IV. Assessment

Display the Biological Clock Assessment Slide Show to your students, allowing them to answer the questions posed on the slide show in writing, perhaps on the back of their activity sheets. This slide show, along with students' answers to the above discussion questions, will provide a good representation of students' knowledge gained through this lesson.

Students should understand the concept of photoperiod as a migration cue for animals. Children should be able to calculate the photoperiod given a particular sunrise/sunset time. They should also be able to link surface color changes with seasonal changes. Finally, children should also be able to compare their own cues for movement with migrational cues for animals.

Answers to the questions on the Assessment Slide Show are as follows:

Slide 2:
Photo 1 (winter: snow) most closely corresponds to the photoperiod seen in Day "C."
Photo 2 (fall: harvest) most closely corresponds to the photoperiod seen in Day "A."
Photo 3 (summer: green grass) most closely corresponds to the photoperiod seen in Day "B."

Slide 3:
1. *A bird would prepare to fly south in the fall. This day would have a photoperiod like Day "A." This photoperiod would indicate to the bird that soon the weather would be changing colder.*

2. Chickens would want to lay the most eggs during the late spring and early summer, so that if the eggs hatch their babies will have warm weather to help them survive their early weeks of life. Such a day would have a photoperiod such as that seen in Day "B." Note that some students may recognize that Day "A" can also represent a springtime photoperiod, which would also be an acceptable answer. Hens usually begin laying eggs in the spring after they begin experiencing about 14 hours of daylight. In fact, some chicken farmers use indoor lighting to change the photoperiod such that it "tricks" hens into laying eggs year-round!

Lesson Extensions for Authentic Assessment

1. Have students plot the photoperiod of their town over the course of the year on a graph, and discuss the trends seen in the photoperiod.

2. Have students choose another site in the world (for example, the wintering site of the Swainson's Hawk as discussed the Hawk in Flight lesson) and calculate the changing photoperiod there over the course of the year. How does the photoperiod of this other site compare with that in the students' home town?

3. Using a globe and a flashlight, show in a darkened room how as the earth changes its tilt, the length of the photoperiod of a location on the rotating globe will change. Which way does the earth tilt in the summer (Northern hemisphere towards sun)? Which way does it tilt in the winter (opposite way)? What are the changes in photoperiod as seen by the changes in the amount of time the globe is lit by the flashlight? Are there any parts of the world that could have a photoperiod of 24 hours, or zero hours (polar latitudes)?