Dendochronology as a Tool for Teaching About Climate Change

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Grade Level: 9 - 12

Summary

This plan is a single lesson on dendrochronology in the middle of a unit on cell structure and function. The goal of this lesson was for students to gain an understanding of plant cell structure and the seasonal variation found in plant cells. Insight into how scientists can use these cell properties to determine important information about past weather patterns and in some cases extract evidence of shifts in the Earth's climate are secondary goals. The ultimate goal will be for students to understand that dendrochronology provides proof that humans are the driving force behind global climate change.

This hands-on investigation allows students to compare two core samples; one removed from a living tree and the other, of unknown age, removed from a timber used to build a structure. Students are to determine the age of the structure wood by correlation of tree ring patterns. The hands-on aspects of this lab requires that students work together, with only minimal direction, to find the matching patterns in the cores. In addition, students are to research and describe other aspects of dendrochronology, especially as they relate to seeing how changes in climate are captured by the tree rings for analysis years later.

Most students understand that tree rings can be used to determine age, but only a few knew about how weather influenced tree ring structure. As an inquiry-style lesson, this activity provides background, relevant science and real research opportunities for the students.

Incorporating the Science Inquiry Cycle

A. Concepts

Plant cell structure varies in response to environmental conditions.

Tree rings provide a record of past environmental conditions.

Dendrochronology provides proof of a shift in global climate.

B. Science Standards

L.12B.1: Students know cell structures and their functions.

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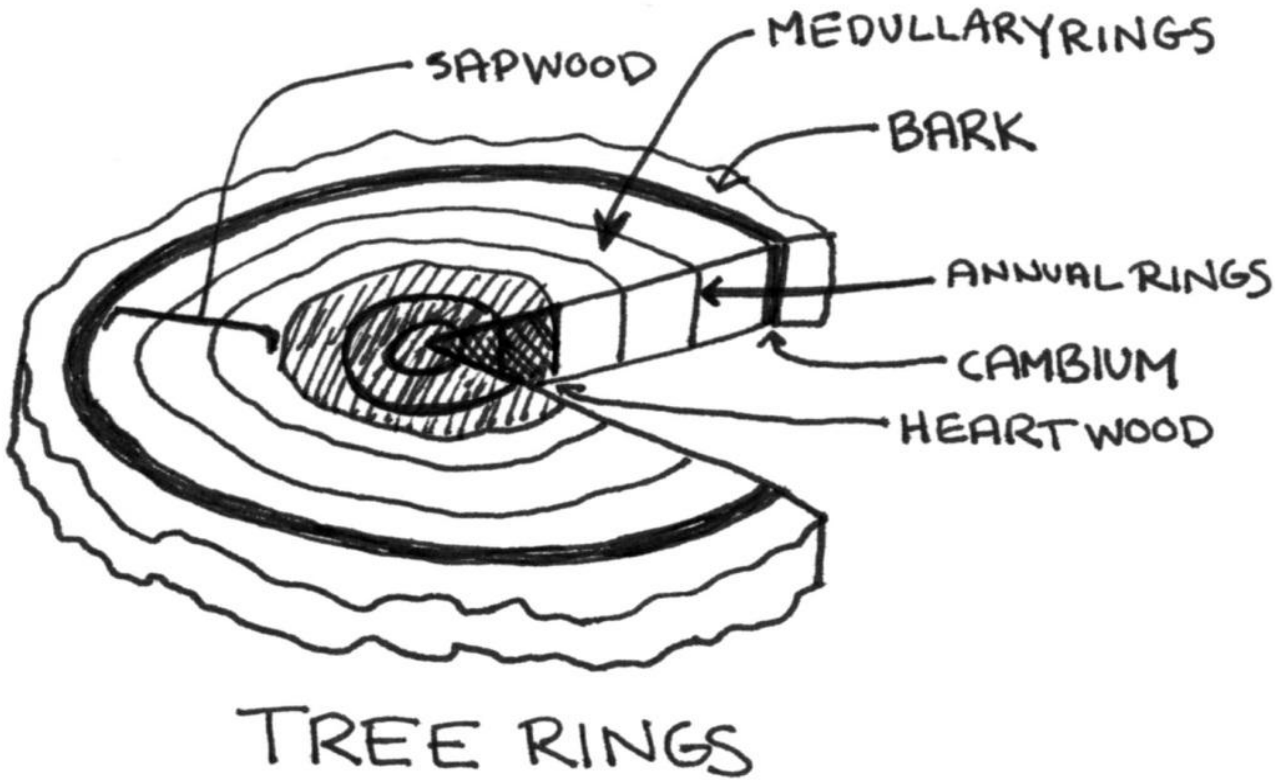
N.12A.2: Students know that scientists maintain a permanent record of procedure, data, analysis, decisions and understanding of scientific investigations.

L.12C: Students understand that ecosystem display patterns of organization, change, and stability as a result of the interactions and interdependencies among the living and nonliving components of the Earth.

L12.C2.: Students know how changes in an ecosystem can affect biodiversity and biodiversity's contribution to an ecosystem's stability.



Basic Procedures

1. Once it is confirmed that all students understand how tree rings are produced, they were asked how we could use tree rings to determine recent weather conditions and past climatic conditions.

2. When given two tree core samples, students are asked to determine how they could determine the age of the core with a known cut date, then hypothesize how they could use this core to determine the age of the core with an unknown cut date.

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3. Students counted rings on each core and found the areas of correlated tree ring patterns.

4. Students then determine the age of the unknown sample and confirm the age with the presence of a forest ranger that lived in the area at the time and built a cabin to live in.

5. Students transfer this understanding of tree ring analysis to tree ring patterns in ancient bristlecone pines and sequoias.

6. Students view examples of dendrochronological data that provide proof of climate change and how it is influencing the range of the bristlecone pine in the White Mountains of California.

Activity as Student-led Investigation:

As much as possible create a classroom climate that supports a student led investigation and keep the activity as much as possible a hands-on lesson. Students will count the rings, made replicas of the rings on paper, and find the area of correlating ring patterns with their lab partners. Some students needed assistance with the math involved in determining age, but otherwise teachers were simply facilitators.

Integration of the Nature of Science into the Science Lessons

Although this particular standard does not seem directly related to climate change, it does address science standard N.12A.2. This standard focuses on importance of maintaining scientific records of procedure, data, analysis and decisions in scientific investigations. The subject of climate change may not spark much debate among students bordering on apathy. Therefore it is important to address the information in a way that is accessible, relevant and causes students to be interested in knowing more. So along with the opportunity that this lesson provides to emphasize the importance of an awareness of climate change, it also provides an opportunity to stress the importance for relying on proof when making decisions. Those who are not sure if climate change is happening need to become familiar with the data provided by tree rings, ice cores and other scientific research and students successfully completing this lesson will be in a very good position to make a decision based on fact.

As a way of introducing the unit, begin with a discussion of the bristlecone pine. The age of the tree is a great hook that cannot fail to start a conversation on what occurred during the life of a 4,800 year old tree. Students can then be introduced to the recent research that shows a shift in the bristlecone's range in the White Mountains. Standard L12.C refers to stability and change in an ecosystem in response to the interdependency between abiotic and biotic factors, and the bristlecone's distribution is a perfect example of these relationships.

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Differentiated Instruction

The student population that many public school teachers work with dictates that differentiated instruction should be the norm in all classes. Much of the student population in classes are comprised of a large number of SIP, ELL and special education students. Students with special needs may be provided aids or co-teachers in the classroom to accommodate large numbers of this category of student. Utilize your resources to maximize student learning and interaction. The large number of ESL students in the classes requires close attention to the SIOP sheltered instruction protocol for students struggling with English and other ELL-designed instructional techniques for diverse student populations.

Assessment Strategies

Assessment for this lesson focused on student analysis of the tree core samples. For the SIP students, an oral explanation of the area of correlation on the cores along with the students demonstrating how they could determine the cut date and the first year of growth is an effective method of assessment. Other students can produce a more formal, written "explanation" of their findings. A few students will have difficulty transferring the pattern of rings from the core to the paper strips, so that section of the lab can be omitted from the assessment.

There will always be a wide range of abilities among the students in these classes. The answers to the questions are of secondary importance and are the focus of the closure portion of the class. As important are discussions as to how students will determine the age of the unknown core. With some students showing their work on the ELMO for the entire class is a good way to determine if learning took place. If able to devote more time to the mathematics of this type of correlation, the dates can be included in the assessment. The ability to correlate the cores should be emphasized for all students. Be alert for the opportunity to use informal assessment techniques during the execution of the activity.

Special education students with lower grade reading levels will require explaining instructions additional times and taking verbal answers to questions. Worksheets and other written lab products may be best assessed as a joint effort with the lab partner(s).

The math associated with this lab is typically the single factor that influences student completion of the assignment. Lessons with any type of math usually require a certain amount of time dedicated to introducing the math before the science lesson begins. A good idea prior to doing the activity is to include a lesson on correlation of dates before focusing on correlation of the tree rings.

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Teacher Comments and Observations

The need for this lesson to fit within a specific time frame was the only way in which the lesson differed from an instructor's usual preparation and teaching routine. The unit may be more effective when it is included in the unit on plants or ecology. Also scheduling the field trip to collect core samples will certainly change student interest and engagement.

Conversations with teachers from our feeder schools suggest that the Five E model of science lesson planning is standard. The approach typically used to teaching science did not change for this lesson. The use of the pre- and post-test was the only change, and, as discussed below, it did seem to change how students chose what to focus on during the activity. The intimidation of the word "test" on the paper may have resulted in students finding these points more important than if they are simply listed as objectives or in the lab analysis.

Pre- and post-test scoring was very interesting for most students. Many seemed more interested in these results that in the results of their weekly quizzes or tests! Students reported that they liked being asked the exact same questions, and said that they focused on parts of the PowerPoint and activity that clarified these questions. Shifting to a more formal way of conducting a formative assessment designed more like the pre-/post-test format can be of great benefit in many science lessons. If this was begun early in the year many students would benefit from the immediate results and the emphasis on which concepts are most important in an activity. This also fits in well with the mastery based learning that many schools are beginning to emphasize.

This lesson was first done in 2010 and coincided with a timely visit to the Hug campus by ACE, the Alliance for Climate Education a week prior to the lesson provided students with an opportunity to find relevance and evidence of the practical application of the concepts they are studying in biology to real world issues. The initiation of the student driven DOT or "Do One Thing" campaign, had students analyzing their roles as individuals in contributing to and hopefully reversing climate change by pledging to do one thing every day to reduce their carbon footprint.

Please share your comments about successes with this method with Denise Tatar, c/o Hug High School, 2880 Sutro Street, Reno, Nevada 89512, 775- 333-5300, or by e-mail: Denise Tatar <dtatar@washoeschools.net>

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