Teacher Guide: Measuring Trees

Learning Objectives

Students will…

- Measure the height, diameter, and circumference of a tree.
- Determine a tree's age by counting growth rings.
- Determine how precipitation affects the growth of a tree.
- Determine how growth changes as a tree ages. (Extension)

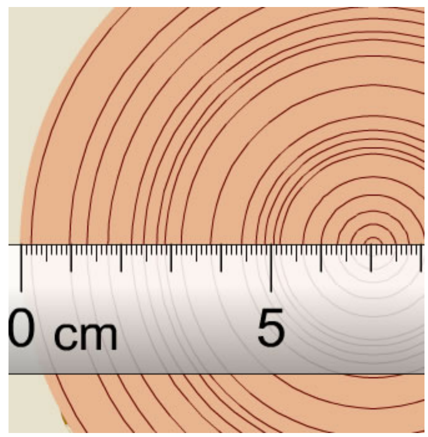
Vocabulary

circumference, cross section, diameter, drought, growth ring, precipitation

Lesson Overview

The *Measuring Trees* Gizmo™ introduces many basic science skills—measuring, estimating, making inferences, graphing, and running simple experiments. The Student Exploration sheet contains a warm-up, two activities, and an extension:

- Warm-up – Students learn that a tree adds a growth ring every year.
- Activity A – Students measure height, diameter, and circumference of several trees.
- Activity B – Students see how precipitation affects tree growth.
- Extension – Students make a graph of tree growth.



Cross section of a tree

Suggested Lesson Sequence

1. **Pre-Gizmo activity** (20 – 40 minutes)
   The *Measuring Trees* Gizmo was designed primarily to develop measurement skills. Have your students practice using rulers and meter sticks to measure lengths and heights. Discuss metric units of measuring length and explain the proper way to record answers.

   An interesting problem in measurement is to find the relationship between the **diameter** (distance across) and **circumference** (distance around) of a circular object. For example, if a soup can is 8 cm in diameter, ask students how long a label for the can would have to be. Also, how would they measure the circumference of the can? (Methods could include wrapping a flexible ruler around the can, wrapping a string around the can and measuring the string, or rolling the can over a ruler.)

   Measure the diameter and circumference of a variety of circular objects. For all perfectly circular objects, the circumference is a little bit more than three times as long as the diameter. (This exact ratio actually equals pi, which is about 3.14.)

2. **Prior to using the Gizmo** (10 – 15 minutes)
Before students are at the computers, pass out the Student Exploration sheets and ask students to complete the Prior Knowledge Questions. Discuss student answers as a class, but do not provide correct answers at this point. Afterwards, if possible, use a projector to introduce the Gizmo and demonstrate its basic operations.

3. **Gizmo activities** (15 – 20 minutes per activity)
Assign students to computers. Students can work individually or in small groups. Ask students to work through the activities in the Student Exploration using the Gizmo. Alternatively, you can use a projector and do the Exploration as a teacher-led activity.

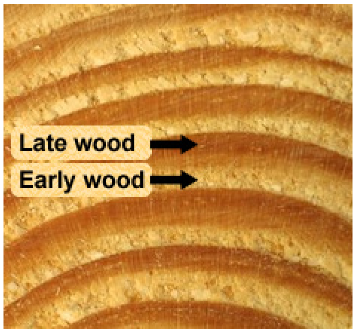
4. **Discussion questions** (15 – 30 minutes)
As students are working or just after they are done, discuss the following questions:

   - How can you determine the age of a tree?
   - What is the relationship between diameter and circumference?
   - What does it mean if you find a tree with several narrow growth rings? What do wide rings indicate?
   - Besides precipitation, what are other factors that could influence tree growth?
   - Do trees keep growing forever, or does their growth slow down at some point?

5. **Follow-up activity** (30 – 60 minutes)
If you can, obtain several cross sections of trees showing growth rings. (If you can't get the real thing, you can print pictures from the Internet.) Practice measuring the diameter and circumference of each cross section. To measure the circumference, use a flexible tape measure or wrap a string around the cross section. Find the age of each tree by counting growth rings.

   Once your students have collected their data, there are several things they can do. Students can compare the width of individual growth rings to identify years with good or bad growing conditions. Students can also compare the width of rings created when the tree was young to those created when the tree was old. Create a graph of age vs. diameter for all the trees in your sample to see if growth rates decrease as the trees age.

Scientific Background



The age of a tree can be determined by counting growth rings. Growth rings, also called **tree rings** or **annual rings**, form each year because the rate of tree growth changes over the course of a year. In temperate climates, trees grow rapidly in the spring, forming a layer of relatively low density, light-colored wood called **early wood**. In the summer and early autumn growth slows and a layer of higher density, darker wood called **late wood** is formed. Little or no wood is formed in the autumn or winter, and the cycle begins again the next spring, resulting in a series of rings.

Many factors can influence how much a tree grows each year. These include rainfall, temperature, availability of nutrients, and amount of light. Disease or attacks by insects can slow the growth of a tree, as can natural disasters such as forest fires. The better the conditions for growth, the wider the growth rings will be. Older trees that are nearing their maximum height do not grow as quickly as younger trees, and will form narrower rings.

To investigate the growth of trees without causing them damage, foresters use a special drill called an **increment borer** to extract a **tree core** from a living tree. Each core is about as wide as a pencil and clearly shows the width of each growth ring.

Using the methods of **dendrochronology**, scientists compare tree rings to reconstruct ancient climates and date important events. For example, if several tree cores exhibit three narrow rings from the same period of time, it could indicate that those three years were periods of drought. (In some cases, *no* rings are created during an extreme drought.)

Climate reconstructions can be extended back in time by comparing the growth rings of living trees to those of dead trees. Timbers ripped from old houses or salvaged from archeological sites can provide valuable data to extend these chronologies thousands of years into the past. The weather patterns revealed by tree rings and other sources of data provide unique insight into historical events and serve as a valuable comparison to present climate changes.

Biology Connection: The Oldest Tree

In 1964, a graduate student named Donald Curry found a large **bristlecone pine tree**, called the "Prometheus Tree," near Wheeler Peak in Nevada. Curry wanted to use the tree to study past climate change, but for reasons that are still unclear he decided to cut the tree down rather than remove a core. As it turned out, he cut down the oldest known living tree on Earth!

A ring count from a breast-high section of the tree revealed that the tree was at least 4,862 years old when it was cut down. That figure increases to approximately 5,000 years old when the time required to reach breast height is considered for these slow-growing trees.

Currently the oldest known living tree is another bristlecone pine nicknamed "Methuselah." Concerned about possible vandalism, the U.S. Forest Service has kept the exact location of this tree a secret.

Is this the Methuselah tree?

Selected Web Resources

Measurement lessons: http://mathforum.org/paths/measurement/e.measlessons.html
Tree ring simulation:
http://www.windows.ucar.edu/tour/link=/earth/climate/dendrochronology_build_tree.html
Dendrochronology: http://www.livius.org/de-dh/dendrochronology/dendrochronology.html
Dendrochronology: http://www.sonic.net/bristlecone/dendro.html
Tree cores: http://www.yale.edu/fes519b/saltonstall/page2.htm
Tree core activity: http://vathena.arc.nasa.gov/curric/land/global/reconstr.html
Record-setting plants: http://waynesword.palomar.edu/ww0601.htm#oldest
Prometheus tree: http://en.wikipedia.org/wiki/Prometheus_(tree)