# *How do we classify living things?*

*Learning how to make and use dichotomous keys and trees*

## Overview

One of the many challenges faced by scientists is how to classify all of the Earth's biodiversity. With so many plants, animals, insects and other forms of life we need a way to identify new organisms and fit them into groups with species that we already know. In this lesson, students will be introduced to dichotomous keys and trees, which are common tools that researchers and naturalists use to identify species in the field. They will first develop a key based on objects that they are very familiar with – their own shoes! After the shoe tree is complete, students will move on to the more difficult task of creating a dichotomous key for all the plants in the BEST experimental plots growing in their school district.

## Objectives

At the conclusion of the lesson, students will be able to:

- Describe what it means to be alive and identify living from non-living things
- Use a dichotomous key and tree to identify a new species
- Create a dichotomous key and tree for a group of objects or species
- Identify all of the species planted in the BEST Experiment

## Length of Lesson

The lesson requires two class periods. The first class will take 10 minutes for the introduction and 20 minutes for the shoe classification. The last half hour can be used to begin on the plant classification. The second class can be used to finish up plant dichotomous key creation.

## Grade Levels

This lesson is appropriate for 6$^{th}$ to 8$^{th}$ grade classes. It fits best with biodiversity lessons taught in the 7$^{th}$ grade curriculum.

## Standards covered

**S.IP.07.13** Use tools and equipment (spring scales, stop watches, meter sticks and tapes, models, hand lens, thermometer, models, sieves, microscopes, hot plates, pH meters) appropriate to scientific investigations.

**S.IP.07.16** Identify patterns in data.

**S.IA.17.13** Communicate and defend findings of observations and investigations.

**S.IA.07.14** Draw conclusions from sets of data from multiple trials of a scientific investigation to draw conclusions.

**K-7 Standard L.OL:** Develop an understanding that plants and animals (including humans) have basic requirements for maintaining life, which include the need for air, water, and a source of energy. Understand that all life forms can be classified as producers, consumers, or decomposers as they are all part of a global food chain where food/energy is supplied by plants that need light to produce food/energy. Develop an understanding that plants and animals can be classified by observable traits and physical characteristics. Understand that all living organisms are composed of cells and they exhibit cell growth and division. Understand that all plants and animals have a definite life cycle, body parts, and systems to perform specific life functions.

**L.OL.07.21** Recognize that all organisms are composed of cells (single cell organisms, multicellular organisms).

**L.HE.M.2** Reproduction- Reproduction is a characteristic of all living systems; because no individual organism lives forever, reproduction is essential to the continuation of every species.

**Materials**

- Handout (*provided*)
- PowerPoint presentation (*provided*)
- One shoe from each student
- Photos (*provided*) or real specimens of each plant in the BEST plots

**Background**

When we say something is alive we mean that it is made of cells, takes in matter and energy from the environment to grow and reproduce, and responds to its environment. There is a great diversity of living things on the Earth, and scientists need a way to organize them. One of the first scientists who tried to do just that was Carl Linnaeus. He came up with a hierarchical system to group species into large and small groups based on their shared characteristics. Linnaeus also attempted to give a name to each species, called binomial nomenclature, based on their genus and species names.

One of the tools that scientists use to classify organisms is called a dichotomous key. A dichotomous key gives two choices at each step, and working through the key you can get the species name of your organism. The key can then be turned into a more visual tree where each branching point represents a choice between two options.

In this activity students will make a dichotomous key and tree of objects they are familiar with (their shoes) and then more unfamiliar objects (the plants growing in our BEST experimental plots).

**Activities of the session**

1. Go through introductory slides, sharing background information with the class.
2. Have them practice using a dichotomous key and tree with the fruit examples in the presentation.
3. To begin the shoe activity, have each student place one shoe in a pile in front of the class.
4. Ask the students to observe their remaining shoe and write down 4 characteristics.
5. Ask the students how they would divide the shoes into two groups.
6. Have a student volunteer come and divide the shoes into the two groups.
7. Begin drawing a dichotomous tree on the board. Make a V and write each group of shoes on one of the branches of the V. This branch represents a choice that someone identifying a shoe would have to make. For example, if the students divided the shoes into sneakers and boots, on one branch you would write “sneakers” and on the other “boots”.

8. Continue to break the shoes into smaller and smaller groups, each time letting the students only divide them into two new groups. Have a new volunteer come up each time to divide the shoes. Continue this process until each shoe is in its own group and you have a full tree on the board.
9. When the tree is complete on the board, take a new shoe (the teachers) and practice using the key. Have the students decide which branch to take at each V until you have identified which student's shoe the teacher's shoe is most similar to.
10. Have each student record the tree on his or her worksheet.
11. Have the students recollect their shoes.
12. Introduce the plant activity, saying that the students will now use the same process to make a key for the plants in the plots.
13. Go through the slides of each plant. Have the class identify characteristics of each plant. This way they will be familiar with the plants when they break into groups.
14. Have the students break into 4 groups in the back of the room and distribute one plant packet to each group.
15. Tell students to spend some time looking at all the plants in the packet. What makes some plants unique? Can they start to identify groups of plants? What characteristics help to distinguish the plants?
16. Once they have looked over all the plants they make begin work on the dichotomous key. In the "description" column they will write their yes or no question, and in the "step" column they will write either "go to _____" and fill in the next available step, or "species name" if the plant is the only one remaining in the group.
17. Students will tend to split the plants into "is it a grass" or "does it have flowers" as the first set of questions. Encourage them to begin with the flower group because they have easier characteristics to work with.
18. Allow students to work on the key until all of the species are listed in the "step" column.

**Resources**

Suggestions for teachers when helping students create their dichotomous keys:

1. First have students spread out all the plants and observe them as a whole group.
2. Encourage students to break plants into "grasses" and "flowering plants" as their first set of groups. Then start with the flowers because they are easier for students to work with.
3. The keys work best if students keep trying to divide groups in half with each question step instead of just separating one plant out of the group at a time. This point can be first driven home with the shoe activity.
4. Some good plant characteristics to use:
    - Flowering vs. grass
    - For the grasses – what shape is the seed head? Does it look like a feather? Bushy tail?
    - For flowering plants – how many flowers grow on each stem? Is there just one at the end of each stem ✳ or a whole bunch ⁂?
    - Flower color
    - How many petals are on each flower ✖✶✷✸? Do all the petals appear to be the same shape ✭ ✤?
    - What is the leaf shape? Is the leaf just one whole circle ●, does it consist of multiple leaves together (like a clover) ✤, does it look like a heart ❥?
    - What does the leaf edge look like? Is it smooth or does it have teeth ≋?

Good websites with plant photos:

- http://www.wildflower.org/plants/
- http://plants.usda.gov/java/
- http://www.carsoncity.k12.mi.us/~hsstudent/wildflowers/index.html
- http://www.dclunie.com/eshelton/wildflow/wildind.html
- http://web4.msue.msu.edu/mnfi/education/fieldguide.cfm

**Extensions and Modifications**

This lesson could be modified for higher grades by going into a discussion about the traits we use when making keys (see last slide in the presentation, provided). For our classification scheme to capture the true relationship between the plants in the plots, we must have used traits that came from a common origin, or ancestor. If we chose traits that arose by convergent evolution, meaning they came from different origins but evolved to perform the same function, then our tree would not represent a true history of how the plants are related. For example, many flowers have evolved over time to become yellow, even if the common ancestor of these plants did not have a yellow flower. Therefore, if one of the steps in our key was “does the plant have yellow flowers” this might not capture a true relationship between plants. If we chose the trait of “is the plant a grass” that would be a question that did capture a true relationship between our plants – all grasses are more closely related to each other than they are to plants with flowers.

**Assessment**

A good way to assess the skills developed in this lesson would be to have a dichotomous key quiz. The students could be provided with new plants to identify and create a key for. One suggestion is to photocopy a page out of a plant field guide and have students create a key for these plants. Once the plots are established, students can practice more with living plants, which could be more difficult than having clear photos to look at.