Ecologists Educators and Schools: Partners in GK-12 Education

# ECOS Inquiry

1. **Contributor's Name:** Sarah Bisbing

2. **Name of Inquiry:** Where do I belong? : An Introduction to the Use of Dichotomous Keys (Part 1)

3. **Goals and Objectives:**
   - **a. Inquiry Questions:** Why do scientists need to classify things? How do scientists classify things? How can we use the physical characteristics of living things to help us identify them in the field? What characteristics can we use to group similar organisms? How can these characteristics be used to create a dichotomous key?
   - **b. Ecological Theme(s):** Observation, classification, identification, and an understanding of why each of these steps are so crucial to science.
   - **c. General Goal:** To provide students with a basic understanding of the art and science of classifying and identifying individuals.
   - **d. Specific Objectives:**
     1. Students will learn how to observe the unique traits/characteristics of an individual species. In order to reinforce this skill, students will take notes and make sketches in their nature journals.
     2. Students will learn why and how scientists classify things.
     3. Students will learn basic plant identification skills and how these skills can be applied to classification and identification of other plants and living organisms.
     4. Students will use the ECOS Natural History Guide, herbarium specimens, and other resources to identify and classify their findings.
   - **e. Grade Level:** **3**-8
   - **f. Duration/Time Required:**
     - → **Prep time:** None
     - → **Implementing Exercise During Class:** 1 class period
     - → **Assessment:** Associated with Part 2 of Inquiry

4. **Ecological and Science Context:**

   **a. Background (for Teachers):**

   There is absolutely amazing diversity in life. Over 1.5 million species on earth are described, 2/3 belonging to the class Insectae of the kingdom Animalia. And this is only a fraction of the actual number of species! Scientists estimate that there are actually 10 to 100 million species on the planet. Wow! In order for biologists to be able to communicate with each other about these many organisms, there must be classification of these organisms into meaningful groups. Scientists sort things into categories using taxonomy, or classification. Organisms that are alike are put into the same group. These groups help scientists keep track of the world's organisms. This system of organization is similar to the way librarians sort books into different sections and on different shelves.

   The art and science behind classification lies in the act of actually slowing down and spending concentrated time looking at things. There are many wonderful things found in nature, including just outside the classroom. These wonders are just waiting to be discovered, but we tend to miss them, however, as we hurry through our everyday lives.

Observational skills are the foundation for most scientific endeavors. All great field biologists are keen observers, and most of these scientists began by making simple observations of nature near their homes or schools.

More than 2000 years ago, Aristotle, a Greek philosopher, created the first system of classification. This system possessed two kingdoms followed by simple categories for naming plants and animals. Centuries later, a Swedish botanist, Carolus Linneaus, developed the basic principles still followed in the modern classification of living organisms. Linnaeus wrote 180 books describing plant species in extreme detail, but his system of classification first arose in his 1735 publication, *Systema Naturae*. Linnaeus surveyed all the world's plants (about 7,700 species) and animals (about 4,400 species) known to exist at the time. In this publication, he outlined a scheme for classifying these known and all yet-to-be-discovered organisms. Linneaus based his system on the similarities and differences among organisms. This system provided order to the methods of classifying living things.

With the guidance of Linnaeus' system of taxonomic classification, biologists classify organisms into different categories mostly by judging the degrees of apparent similarity and difference visible. The assumption is that the greater the degree of similarity, the closer the biological relationship. So, organisms are then lumped together based on these assumed homologies. By organizing living things into different branches, we can better understand how closely or distantly they are related.

In order for taxonomists worldwide to communicate, we use Latin or Greek to name organisms. Common names vary greatly from place to place (and person to person), creating much confusion as to what organism a person is actually talking about. To avoid these problems, scientists throughout the world use standard scientific names to identify things. These names are comprised of two words, a genus name (the general group) and a species name (the specific kind). The species name is usually a descriptive word, adjective, or related to the name of the person who first discovered it. This system of naming organisms is known as binomial nomenclature, meaning "two-word naming." This system of classification and naming, as developed by Linnaeus in the 1700's, is alive and well. Since Linnaeus' day, scientists expanded the system to include: more than one million animal species; 350,000 plant species; 100,000 Fungi species; and over 100,000 other microorganism species.

The driving goal of classification is to promote accurate identification of an organism to aid in scientific communication. How can a scientist know the benefits or uses of an organism without knowing the identity of that organism? Just about anywhere you look, you will find members of the plant kingdom: flowers in you mother's window box, trees along the schoolyard, the veggies we eat for dinner. Members of this kingdom provide habitat and food for other living things. Plants are our main source of medicines, disease control, fuel, clothing, and food. In order for us to make use of these resources, we must first know how to correctly identify them.

Dichotomous keys are the most widely used form of classification in the biological sciences. This is the case because they offer the user a quick and direct means of identifying unknown organisms. Dichotomous means "divided into two parts," so dichotomous keys always give two choices at each step. The key consists of a series of choices that lead the user to the correct name of the given item. The key works by offering two alternatives at each juncture. Statements tend to describe contrasting characteristics, guiding the user toward the correct choice. The choice of one of those

alternatives determines the next step and eventually leads to the correct given name of the item in question. Dichotomous keys are distinctive because they are ordered in such a way that a series of choices leads the user to correctly identify the unknown item. They also teach users the characteristics most important in observation for use in identifying a group of plants (i.e.: flower or fruit shape, plant parts, leaf shape, etc).

**b. Background (to present to Students):**

Each individual species in nature (plants, animals, insects, etc.) possesses unique traits and characteristics. These characteristics can be used to identify and classify these individuals based on similar characteristics. Knowledge of which species are present in an area can tell a scientist/naturalist a lot about the area (ecology, geology, climate, animal activity, even human history). Knowledge of these species also allows us to make use of them.

## 5. MOTIVATION AND INCENTIVE FOR LEARNING:

Students are given the opportunity to learn about the seemingly boring topic of taxonomic classification in a manner that is fun and interactive. The initial investigation allows the students to participate in a hands-on activity in which they group and classify their shoes. This gives students the opportunity to gain an understanding of taxonomy and the use of dichotomous keys through the classification of objects they are familiar with and use every day. The lesson then goes on to expand on this new-found knowledge by giving students the opportunity to key out organisms from the natural world. Students should be able to observe differences between the given organisms and feel the satisfaction of correctly identifying an organism with the techniques of a true naturalist or scientist.

## 6. Vocabulary:

- Taxonomy = the science of classifying organisms based on their natural relationships
- Dichotomous Key = a tool that allows a user to classify and identify organisms in the natural world based on the idea that each specimen has either one trait OR another.
- Classification = the organization of things into groups
  = the structuring of data used to group individuals into categories based on their evolutionary and/or taxonomic characteristics
- Observation = a record of something noted or seen
- Identification = the process of identifying the correct name of a given item
- Genus = a taxonomic group of a set of closely related species, below the family level and above the species level.
  = a class of objects divided into subordinate species having certain common attributes
- Species = a category of taxonomic classification consisting of a group of organisms that resemble one another closely

= applied to one or more groups (populations) of individuals that can interbreed within the group but cannot exchange genes with other groups
= in terms of plants, this group does not normally interbreed in nature, but do have the ability to exchange interbreed/hybridize

7. **Safety Information:** No Safety Issues.

8. **Materials List (including any handouts or transparency masters):**
    - Nature Journals for each student

9. **Methods/Procedure for students:**
    a. **Pre-investigation work:**

        1. **Pre-Inquiry Classification Discussion:** Prior to starting this inquiry, the teachers should initiate a discussion about the role of classification in science and the role of journaling/naturalist skills. Ask the students a number or questions. Can you think of any time in your life when you organize and classify things (clothes in a drawer/closet, food in the pantry, homework in separate folders, etc)? What characteristics do we use to classify things in our everyday lives? Why would a scientist need to classify something? Why is classification a crucial part of science? In order to classify living things, what characteristics would a scientist need to focus on?

        2. **Pre-Inquiry Journaling Discussion:** Present the idea of journaling (through note-taking and sketching) as a means of making observations of the natural world. Tell them that a naturalist is a scientist who studies nature to understand how it works. They need only their senses, their curiosity, and the ability to spot clues and ask questions. Tell them that in their journaling they should look closely and take notes on what they see. Students can use their journals to press flowers/leaves, make sketches, and write down their observations. They should date all entries and label all pictures. Tell them to use their own "natural" curiosity to ask questions and find more about the natural world in their area. Remind students that it's okay if their drawings are not perfect. Mistakes are all part of the learning process, and they will improve as they begin drawing.

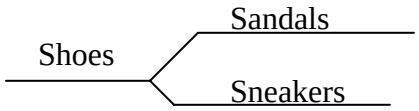
        3. Discuss the role of dichotomous keys in classification (using above background material). Tell students they will be going through the process of organizing and classifying both living organisms and things common to their everyday lives.

    b. **Investigation work:**

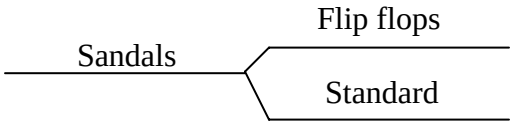
        1. **Constructing a Dichotomous Key**:

        Arrange chairs in a circle. The teacher should remove one shoe and place it in the center of the circle. Explain to the students that we are going to separate, organize, and classify our shoes. Ask for 11 volunteers (12 shoes total) to remove one of their shoes and place it in the center of the circle. Tell the students they are to divide the shoes into two piles. The piles do not need to have an equal number of shoes. Instead, the shoes should be grouped

according to obvious characteristics that distinguish the shoes in one pile from shoes in the other pile (sneakers vs. sandals). After agreement is reached among the students, begin a record of the separation on the board.




Draw two horizontal lines some distance apart on the chalkboard. Label the lines with the agreed upon characteristics. Then return to the pile of shoes. Have the students focus on one pile of shoes. Ask them how these shoes can be further divided into two separate categories of similar characteristics (flip flops vs. standard sandals, one strap vs. two straps). After and agreement is reached, go back to the board and add this information to the chalkboard sketch.




Continue the process of diving shoes into two distinct piles and adding the information to the board until there is only one shoe left with a unique, identifying characteristic. At this point the shoe is identified and the owner's name is added to the description on the chalkboard (pink, floral flip flop owned by Jane).

Have the students redeem their shoes. Ask for a volunteer to donate one shoe not previously used in the classification scheme. Have the students attempt to use the key to get at the unique, identifying characteristic and owner's name. The students should only be able to get so far. At some point the new shoe will not fit into the classification scheme, because its characteristics and owner's name were not used in the creation of this dichotomous key.

This investigation should give students the opportunity to get a better grasp on the "why" and "how" behind taxonomy, or classification. Through the use of shoes, students are able to separate and organize items that are crucial part of their lives. This activity brings the art of classification closer to home.

**2. Creating a Dichotomous Key for Schoolyard Species:**

Break students into groups. Give them 10 minutes to walk around the schoolyard and select at least two plant species. Have students make notes and sketches on each of the species found. Bring the students back into the classroom and have them go through the process of organization and classification for these two species. Remind them that they need to separate each into groups of two until they reach the identification for the species. Allow students to select characteristics used to distinguish between the two specimens. In the end, have the students make up goofy, easy-to-remember names for each species.

**10. Assessment:** Associated with Part 2 of Inquiry.

**11. Extension Ideas:** Follow up this inquiry with Where do I Belong?: An Introduction to Dichotomous Keys (Part 2).

**12. Scalability:** This inquiry itself is very basic. Worksheets are attached to Part 2 that match varying age groups, such as 3-5, and 6-8.

**13. Science Standards Accomplished:**

- Science as a Human Endeavor
- Characteristics of Organisms
- Diversity and Adaptations of Organisms
- Abilities to Distinguish between Natural Objects and Objects Made by Humans
- Nature of Science
- History of Science

**14. References:**

http://en.wikipedia.org/wiki/Dichotomous_key
http://oregonstate.edu/trees/dk/index.html
http://www.seaworld.org/just-for-teachers/guides/diversity-of-life/diversity.html
http://anthro.palomar.edu/animal/animal_1.htm
http://www.cbs.umn.edu

The American Heritage® Dictionary of the English Language, Fourth Edition


**15. List of Experts and Consultants:**

Jeff Piotrowski
Paul Alaback

# Guide to Leaf Arrangements and Leaf Shapes:

## Leaf Arrangement

Alternate

Fascicled

Opposite

Whorled

## Additional Leaf Arrangement Characteristics:

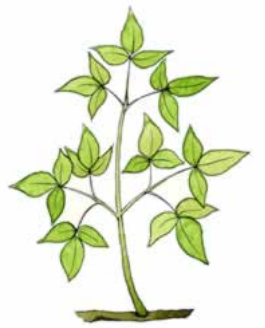
Bipinnate

Pinnate

Palmately Lobed

Simple

Palmately Compound



Tri-ternate

**Leaf Shape**

Cordate (heart shaped)

Elliptic

Lanceolate

Linear

Oblanceolate

Oblong

Obovate

Orbicular

Ovate

Acicular (needle-shaped)

# Where Do I Belong?

**Species 1**:

Leaf Shape: _____

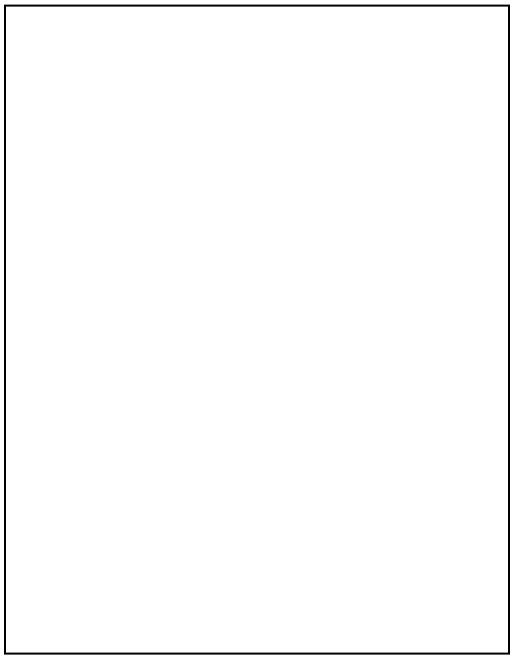
Leaf Arrangement: _____

Flower Color: _____

**Species 2**:

Leaf Shape: _____

Leaf Arrangement: _____



Flower Color: _____

**Species 1:**

## Name of Unknown Species 1: _____

What is the lifeform of this sample? _____

Where does this plant grow? Where is its favorite place to live? _____

_____

What is the origin of this plant? If not native, where does this plant come from? _____

Does this plant have any special uses? If so, what are they? _____
_____

Can you find any interesting facts about this plant? _____
_____
_____

Please make a new sketch of your plant in your journal based off the photos from the ECOS guide.

**Species 2:**

## Name of Unknown Species 2: _____

What is the lifeform of this sample? _____

Where does this plant grow? Where is its favorite place to live? _____
_____

What is the origin of this plant? If not native, where does this plant come from? _____

Does this plant have any special uses? If so, what are they? _____
_____

Can you find any interesting facts about this plant? _____
_____
_____

Please make a new sketch of your plant in your journal based off the photos from the ECOS guide.

**Compare and Contrast:**

Do these plants have similar characteristics? _____

If so, what are they? _____

_____

What are the major differences between these two plants? _____

_____

_____

**Yeah! You're done! Congratulations, beginner naturalist!**

# Where Do I Belong? :
## An Introduction to the Use of Dichotomous Keys

**Part 1:**

Directions: Use the handout, leaf samples, notes, and illustrations to answer the following questions. After finishing the section, we will use a computerized field guide/dichotomous key to accurately identify your species.

To get to the field guide, type http://www.bioed.org/nhguideweb/ in the "Address" box at the top of the page. Select "Identify a Plant" on the left side of the page. Use the answers from your worksheets to make selections. First, select the boxes to the left of the fields to be used in identification (leaf type, leaf arrangement, and flower color). Then scroll to the correct characteristic and type in the color of the plant. Once these characteristics are selected, hit SEARCH at the bottom of the page. You will be given a few plant names. Use your samples, notes, and illustrations to select the correct species.

**Species 1:**

Leaf Shape: _____

Leaf Arrangement: _____ Flower Color: _____

Name of Unknown Species 1: _____

**Species 2:**

Leaf Shape: _____

Leaf Arrangement: _____ Flower Color: _____

Name of Unknown Species 2: _____

**Part 2:**

Directions: Now that you know the correct names of your samples, let's learn a little about their homes (habitats), histories (origin and uses), and their lives (family, flowering, life cycle). Find your species in the ECOS guide again. Go to

"Select a Plant by Name" and type in the name of your species. Look through the description and answer the following questions.

**Species 1:**

What is the lifeform of this sample? _____

What family does this specimen belong to? _____

Where does this plant grow? Where is its favorite place to live? _____
_____

What is the origin of this plant? If not native, where does this plant come from?
_____

Does this plant have any special uses? If so, what are they? _____
_____

Can you find any interesting facts about this plant? _____
_____
_____

Please make a new sketch of your plant in your journal based off the photos from the ECOS guide.

**Species 2:**

What is the lifeform of this sample? _____

What family does this specimen belong to? _____

Where does this plant grow? Where is its favorite place to live? _____
_____

What is the origin of this plant? If not native, where does this plant come from?
_____

Does this plant have any special uses? If so, what are they? _____
_____

Can you find any interesting facts about this plant? _____
_____
_____

Please make a new sketch of your plant in your journal based off the photos from the ECOS guide.

**Part 3:**

Directions: Go back and look at your answers to the questions above. Compare and contrast your answers for the two species.

Do these plants have similar characteristics? _____

If so, what are they? _____
_____

What are the major differences between these two plants? _____
_____
_____

**Yeah! You're done! Congratulations, beginner naturalist!**