A Dichotomous Key of Virginia's Native Plants

Strands	Life at the Systems and Organisms Level; Scientific Investigation
Topic	Classifying organisms and undertaking field studies
Primary SOL	BIO.6 The student will investigate and understand bases for modern classification systems. Key concepts include a) structural similarities among organisms; e) systems of classification that are adaptable to new scientific discoveries.
Related SOL	BIO.1 The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which a) observations of living organisms are recorded in the lab and in the field; b) hypotheses are formulated based on direct observations and information from scientific literature; e) conclusions are formed based on recorded quantitative and qualitative data.

Background Information

Classifying organisms can be traced back to early humans. Aristotle had his own system of categorizing life forms into just plants and animals. As time moved on, people realized that all life forms do not fit into just those two categories. Carl Linnaeus created a more specific hierarchal system for categorizing forms of life. He based his system on the characteristics of organisms' life processes, not just their physical appearance and structures. His broadest classification system consists of **kingdoms**, and his specific system consists of **species**. Species are organisms that can breed to produce fertile offspring. Species are named by using a system called "binomial nomenclature." Names in binomial nomenclature are "scientific names," consisting of genus and species names written in Latin. For example, humans' scientific name is *Homo sapiens*. The genus name is always initial cap, the species is always lower-case, and the entire name is written in italics to indicate it is in a foreign language—in this case, Latin. This is the smallest classifying group.

Because of Linnaeus's system, **taxonomy** was born. Taxonomy uses characteristics of organisms to place them in groups. The groups start out large and broad and get smaller and smaller as organisms fall into subgroups. A **dichotomous key** is a method used in science to place organisms into subgroups and, eventually, species groups. A dichotomous key is what enables scientists to properly name and identify organisms.

Materials

- 20 different native Virginia plants from which to collect leaf specimens
- Digital cameras or field journals and drawing pencils
- Internet access
- How to Make a Dichotomous Key handout (attached)
- How to Make a Cladogram handout (attached)

Vocabulary

binomial nomenclature, clade, cladogram, class, classification, domain, family, genus, kingdom, order, organism, phylogeny, phylum, species, taxonomy

Student/Teacher Actions (what students and teachers should be doing to facilitate learning)

In this lesson, students will create a dichotomous key for at least 20 Virginia plant (leaf) specimens collected from the field to accurately place the specimens into subgroups. When students are finished classifying them, they will also determine their scientific names and place both their common names and scientific names in the dichotomous key.

This lesson is a post-learning activity. Before undertaking it, students should have background knowledge of dichotomous keys and how organisms are classified. Examining an example of a dichotomous key to see how it is designed and works is necessary for students to be successful in this lesson.

This activity is designed as an outdoor field study, but if that is not possible, pictures or samples obtained by the teacher will also work. When students collect leaf specimens, remind them to stay clear of certain types of harmful plants (e.g., poison ivy, poison oak) that may exist in the area.

Prior to engaging in this lesson, students should complete the lesson entitled "The Parts of an Experiment: Introduction to Inquiry and the Scientific Process" in order to gain more experience in designing experiments and writing lab reports. That lesson also includes generic differentiation strategies for general inquiry lessons.

1. A good way to start the class is to display pictures of five different organisms and have students brainstorm, either as a class or in groups, how they would separate these organisms, based on their characteristics. Tell them to start with broad similarities and differences and then move to more specific ones. Guide students to keep putting the organisms into subgroups until every organism is in its own group. This will demonstrate how a dichotomous key is made.
2. Have students collect at least 20 leaf specimens, using one of the following options:
   - Go to a leafy area, write down observations about entire plants and their leaves, and collect leaf specimens to bring back to the classroom for observation.
   - Go to a leafy area, draw leaf specimens, and write down observations about entire plants and their leaves without touching the plants.
   - Go to a leafy area, take pictures with a digital camera of leaf specimens, and write down observations about entire plants and their leaves without touching the plants.
3. Make sure students record in their field journals all their observations about where they found the leaves and about the plants from which they obtained them. Emphasize that the more detailed and specific the traits and characteristics they write for each specimen, the easier it will be to create their dichotomous key.
4. Back in the classroom, have students design a dichotomous key, using the specimens they collected. Facilitate work by walking around the classroom to help students with questions and problems.

Assessment

- **Questions (using Bloom's taxonomy)**
  - What is the best approach for categorizing organisms in a dichotomous key?
  - Compare your dichotomous key to those of several other students. How is it similar? How is it different?
  - Were there any characteristics of the a specimen that other students noticed but you didn't? If so, what were they?
  - How is genetics used to classify organisms? Is it more accurate than a dichotomous key? Explain.
  - What is the difference between a cladogram and a dichotomous key?
  - What does a dichotomous key tell us about an organism?
- **Other**
  - Create and use a scoring guide for dichotomous key.

Extensions and Connections (for all students)

- Have students create a dichotomous key of another kingdom, phylum, class, or order of organisms found in Virginia. For example, have them check out different arthropods common to your area. Have them choose 10 different organisms native to Virginia for which to create their dichotomous key, following the same procedure and expectations they did in their plant dichotomous key.
- A cladogram is an illustration to show evolutionary relationships among different species. It looks very similar to a family tree. Have each student create a cladogram or phylogenic tree showing the evolutionary relationships of six different species. This means students will have six branches in their cladograms. Have them start with a common organism in your area, and work backwards, showing evolutionary relationships with other species that may or may not be extinct. Direct them to create a chart next to their cladograms to describe the derived traits and the differences in each species. Also, be sure they include scientific names next to all pictures and number each clade on the cladograms.

Strategies for Differentiation

- Employ flexible groupings of students by grouping them according to common readiness levels, shared interests, or diverse strengths.
- Allow student to choose how to describe each organism, either through illustration or through written description.

How to Make a Dichotomous Key

Procedure

1. Collect all the samples or specimens you will be categorizing and classifying in a dichotomous key.
2. Make careful observations of the physical structures and other characteristics of your specimens.
3. Divide your specimens into two groups, based on their structures and/or other characteristics.
4. Record this distinction, and record the placement of each specimen in its group.
5. Divide each of these two groups based on one structural difference or one single characteristic.
6. Repeat steps 3 and 4 over and over until you have only one specimen per group.
7. You can now write out your dichotomous key. You have separated your specimens by different structures and other different characteristics.
8. Be sure to include in your key the common name and scientific name of each specimen.
9. Compare your key to a reference dichotomous key found on the Internet.

How to Make a Cladogram

Procedure

1. Choose a group of organisms among which to illustrate evolutionary relationships.
2. Create a data table of characteristics of each organism.
3. Make careful observations of the physical structures and other characteristics or your organisms.
4. Divide your organisms in two groups, based on their structures and/or other characteristics.
5. Record this distinction, and record the placement of each organism in its group.
6. Divide each of these two groups based on one structural difference or one single characteristic.
7. Repeat steps 4 and 5 over and over until you have only one organism per group.
8. Now, create a diagram (a tree with branches), putting each organism in the appropriate branch of the tree based on similar characteristics. You have separated your organisms by different structures and other different characteristics.
9. Be sure to include in your key the common name and scientific name of each organism.
10. Compare your cladogram to a reference cladogram found on the Internet. Remember, a cladogram shows only evolutionary relationships.