Activity Overview

In this activity, students practice making and using a dichotomous key to identify objects by their specific characteristics. After creating a dichotomous key using their own shoes (or other objects), students practice keying out and identifying individual shoes (or other objects). Students next work in teams to create a dichotomous key of desert plants. Referring to a set of photographs of selected desert plants, students make careful observations of the plants’ characteristics and use those characteristics to create their keys. Teams then switch keys and use another team’s key to identify the plants. The teacher then leads a class discussion on the characteristics used to identify plants and specifically, characteristics of desert plants. Finally, in preparation for their investigation at the Desert Botanical Garden, the class develops a hypothesis about how to identify plants in the cactus family.

To support the Inquiry in the Garden lesson plans, you may also use the tutorials and Virtual Habitat in DBG’s Digital Desert. These interactive activities will prepare students for their investigations by teaching them about the characteristics of deserts and the Sonoran Desert habitat.

Materials

(Note: All of the following materials are provided as downloadable graphics.)

Steps to Making a Dichotomous Key (prepared for use on an overhead projector or smartboard)

Student Study Guide – Key to Desert Plants

2 pictures of each of the following plants:

- Plant A- Mesquite Tree (*Prosopis spp.*)
- Plant B- Palo Verde Tree (*Parkinsonia microphylla*)
- Plant C- Creosote Bush (*Larrea tridentata*)
- Plant D- Brittle Bush (*Encelia farinosa*)
- Plant E- Engelman’s Hedgehog (*Echinocereus engelmannii*)
- Plant F- Sweet Noor (*Euphorbia coerulescens*)
- Plant G- Snowflake (*Euphorbia polygona*)
- Plant H- Moroccan Mound (*Euphorbia resinifera*)
- Plant I- Whortleberry (*Myrtillocactus geometrizans*)
- Plant J- Teddy Bear Cholla (*Cylindopuntia bigelovii*)
- Plant K- Pereskia (*Pereskia sacharosa*)
LEARNING OBJECTIVES

Upon completion of this activity, students will be able to...

- Create a dichotomous key to identify individuals in a group.
- Use a dichotomous key to identify individual objects or plant species.
- Use characteristics of plants as identifying features to establish their identity using a dichotomous key.
- List and describe some characteristics of desert plants.
- Explain how some plant characteristics help them survive in their environment.
- State a hypothesis about the characteristics of cacti.

BACKGROUND KNOWLEDGE

These are concepts the educator should understand and that can be found in the glossary.

Dicotomous Key          Family          Convergent Evolution

ACTIVITY PROCEDURES

1. Introduction.

Explain to students that they will be visiting the Desert Botanical Garden where they will be using dichotomous keys to identify and study desert plants. Through an inquiry discussion, review with students the name of our desert (the Sonoran Desert) and the characteristics of deserts in general (hot, dry, high evaporation, low rainfall, and extreme temperature fluctuations).

2. Review dichotomous key.

Ask if any students have experience using a dichotomous key and discuss their experiences. Explain that a dichotomous key is a tool used to identify something (such as plants, insects, rocks) by going through a series of choices that ultimately lead to the identity of the object. Dichotomous means “divided into two parts” and a dichotomous key offers two choices at each step. Scientists typically create and use dichotomous keys to identify things based on their observable characteristics.
3. **Review the steps to making a dichotomous key.**

Point out that since dichotomous keys use characteristics of objects, you can create them to identify an individual from a group of just about any kind of objects. In this case, the class will create a key to identify individual shoes. Display the *Steps to Making a Dichotomous Key* on the overhead projector or smartboard. Review and discuss the steps with students then ask if they’re ready to give it a try.

4. **Create dichotomous key using students’ shoes.**

Explain to students that they will now create a dichotomous key with their own shoes. Call on 10 students to volunteer their right shoes as the objects to key out. Place the shoes where everyone can see them (if necessary, have students sit in a large circle with the shoes in the middle). Using the steps outlined in the *Steps to Making a Dichotomous Key* have students work together to create a dichotomous key to the shoes. As distinguishing characteristics are identified to separate each group of shoes, physically separate the shoes into piles. Each grouping should also be written out on the board in spider form. When all shoes are separately identified, write the key out in traditional form. *(Note: If students are reluctant to use their own shoes, other objects, such as school supplies may be substituted.)*

5. **Use the key to key out individual shoes.**

Once the key is complete, practice keying out individual shoes. To do this, place all the shoes in one pile and have a student pick up (or point out) any shoe in the pile. Starting at #1 on the key, make the choices presented until the shoe is identified. Try this with several shoes until students are comfortable using the key.

6. **Divide students into teams to create dichotomous keys for plants.**

Tell the students that they will now use their new skill to create a dichotomous key to identify individual plants from a set of photos. Divide students into 4 teams. Give each team a set of the plant photos. *(Note: You may create more teams if necessary given class size, just be sure there are an even number of teams and that each team has a set of photos.)* Hand out a copy of the *Student Study Guide – Key to Desert Plants* to each student. Instruct students to follow the directions on the Study Guide to key out their plants. Students should work with their team but each student should complete their own study guide.
7. **Have students switch keys with other teams. Use those keys to key out plants.**

   When all teams have created their dichotomous keys, have teams switch keys. Since all the plant photo sets are the same, have teams keep their own photos but use the other team’s key to key out each individual plant. If time permits, teams may switch keys again with a different team. All students should then answer the “Questions for Discussion” in their Study Guides.

8. **Conduct a class discussion using the “Questions for Discussion” as a guide.**

   Focus the class discussion first on *Part A of the Questions for Discussion*. Stress the use of distinguishing characteristics to identify plants. Discuss the characteristics students used in their keys and note similarities and differences in different teams’ keys. Point out that they actually did just what scientists do in constructing a key; they used the characteristics they felt were most distinguishing to create their keys. There was likely some difference between teams, which also happens with scientists.

9. **Discuss characteristics specific to desert plants.**

   Discuss the characteristics of desert plants that are likely adaptations for survival. Point out that because water is a limiting factor in the desert, plants with those characteristics may have a better chance of survival. Have students list and discuss how some of those characteristics might aid a plant in survival (e.g., small leaves to conserve water, light colors to stay cool, etc.).

10. **Discuss the characteristics of cacti.**

    Using the *Part B Questions for Discussion* as a guide, discuss the characteristics of cacti. Have students refer to their photo sets during the discussion. Ask students what they listed as distinguishing characteristics of cacti. List their responses on the board. Explain that during their field trip to the Desert Botanical Garden, they will have the opportunity to study cactus up close and learn more about their identifying characteristics. In preparation for that investigation, they need to come up with a hypothesis about what the distinguishing characteristics of plants in the Cactus Family are. Review the list of characteristics with the students and help them come up with a hypothesis about how to identify plants in the cactus family. Guide students to come up with the following hypothesis:

    *Plants with spines, green, fleshy stems, and rounded growth form are in the Cactus Family.*

*continued*
SPECIAL NOTE TO TEACHERS: This hypothesis is clearly derived from the characteristics observed in the photos of all the “cactus-like” plants in the students’ photo sets. Please note that during your trip to the Desert Botanical Garden, this hypothesis will actually be proven incorrect as students study a variety of “cactus-like” plants and observe characteristics specific to the cactus and other plant families. By arriving with this hypothesis, students will have the opportunity to work through the scientific method to better understand not only the characteristics of plants in the cactus family, but of how the scientific process works.

11. Have students write down and remember their hypothesis in preparation for their field trip.

Remind students that during their field trip, they will be making observations and gathering evidence to test their hypothesis. They will be following the scientific method in their investigation! Have each student write down the class hypothesis on their Student Study Guide and be prepared to share their hypothesis with their guide during their field trip.
**Learning Objectives**

1. Look at the group of objects or organisms and note distinguishing characteristics.
   (For shoes, this could be shoes having laces, leather shoes, sandals, tennis shoes, white shoes, etc.)

2. Separate the group into two groups based on a single distinguishing characteristic.
   (For shoes, this could be those with laces and those without laces.)

3. Continue to separate each of the groups into two additional groups again based on a single distinguishing characteristic.
   (For the group of shoes with laces, this could be tennis shoes and not tennis shoes.)

4. Continue separating each grouping until each object has its own separate set of characteristics.

To help visualize the key as it is being created, it is helpful to create a “spider” key to chart the characteristics. For a group of shoes, this might look like the following:

```
Shoes
  ├── shoes with laces
  │    └── tennis shoes
  │         ├── white ............. Helen’s shoe
  │         └── orange ............. John’s shoe
  └── shoes without laces
      └── not sandals .............. Ryan’s shoe
          └── sandals .............. Marco’s shoe
```

Once the key is complete and every object is identified, the same information may be presented in traditional dichotomous key form:

1. a. shoes with laces .......................................................... go to #2
   b. shoes without laces ......................................................... go to #4
2. a. not tennis shoes ......................................................... Emily’s shoe
   b. tennis shoes .............................................................. go to #3
3. a. white ................................................................. Helen’s shoe
   b. orange ................................................................. John’s shoe
4. a. not sandals ............................................................ Ryan’s shoe
   b. sandals ............................................................ Marco’s shoe

Using the traditional dichotomous key, one should be able to pick up any object included in the key and follow the steps to arrive at its identity. Try it!
Be sure everyone on the team can see all the plant photos. Observe the photos carefully. As a team, note and discuss the distinguishing characteristics of the plant.

Working in your team, develop a dichotomous key for your eleven plants based on the distinguishing characteristics. Follow the same steps previously used for creating a dichotomous key. The plants’ identities for this activity are simply Plant A, Plant B, and so forth. Use those names in your key. Draw a spider key first then create a traditional dichotomous key. Use a separate piece of paper for each.

Once all teams have completed their keys, trade keys with another team. While they are using your key, follow the steps on their key to identify each of the plants. Note differences in the distinguishing characteristics they used and in how they set up their key. If time permits, trade keys with a different team.

Answer the questions below and be prepared to discuss them with the class. For Part B, you will want to refer to your set of plant photos. Save Question 4 of Part B to answer as a class.

Part A. Characteristics of Desert Plants

1. What were the distinguishing characteristics of the plants your team used to construct your key? List them below.

2. Were other teams’ keys exactly like yours? Describe the differences and similarities in your keys. Include a list of the distinguishing characteristics other teams used in their keys that you did not use in yours.

3. Even if other teams used different characteristics in their dichotomous keys, were the results still the same and did you arrive at the correct plant? Do you think it matters which characteristics are used in a key? Why or why not?

4. All of the plants you keyed out are desert plants. List and describe any distinguishing characteristics you can observe that might be adaptations to help plants survive in the desert. Include how the adaptations likely help the plant survive desert conditions.

5. Did any of the plants you keyed out look familiar? List the plant you think you know. If you do not know the exact name, list what kind of plant you think it might be.
Part B. – What Makes a Cactus, a Cactus?

Answer Questions 1, 2, & 3 on your own. You will answer Question 4 during your class discussion.

1. How many plants from your photo set do you think are cacti (in the Cactus Family)? List those below using their “names” from the photos (e.g., Plant A, etc.). (Note: You may refer to your photos again if necessary.)

____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________

2. What distinguishing characteristics do you observe in your photos that lead you to believe that a particular plant is a cactus? List those characteristics below.

____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________

3. Do you think these characteristics are exclusive to plants in the cactus family? Explain your answer.

____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________

4. During your trip to the Desert Botanical Garden, you will be following the scientific method to investigate how to identify plants in the cactus family. In preparation for that investigation, based on what you have observed in your photos, your class should develop a hypothesis about what the distinguishing characteristics of plants in the Cactus Family are. State that hypothesis below.

____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
____________________________________________________________________________________
PLANT A
PLANT B
PLANT C
PLANT D
PLANT E
PLANT F
PLANT G
PLANT H

16.
PLANT J
PLANT K
## Related ADE Standards:

### Reading Strand 1: Reading Process

<table>
<thead>
<tr>
<th>Concept</th>
<th>Performance Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>C6: Comprehension Strategies</td>
<td>PO 4: Use graphic organizers in order to clarify the meaning of the text.</td>
</tr>
<tr>
<td></td>
<td>PO 5: Connect information and events in text to experience and to related text and sources.</td>
</tr>
<tr>
<td></td>
<td>PO 6: Apply knowledge of the organizational structures (e.g., chronological order, compare and contrast, cause and effect relationships, logical order) of text to aid comprehension.</td>
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<tr>
<td></td>
<td>PO 7: Use reading strategies (e.g., drawing conclusions, determining cause and effect, making inferences, sequencing) to interpret text.</td>
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</table>

### Reading Strand 3: Comprehending Informational Text

<table>
<thead>
<tr>
<th>Concept</th>
<th>Performance Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1: Expository Text</td>
<td>PO 5: Locate specific information by using organizational features (e.g., key/ guide words) in expository text.</td>
</tr>
<tr>
<td></td>
<td>PO 8: Interpret graphic features (e.g., charts, maps, diagrams, illustrations, tables, timelines, graphs) of expository text.</td>
</tr>
<tr>
<td></td>
<td>PO 9: Apply knowledge of organizational structures (e.g., chronological order, comparison and contrast, cause and effect relationships, logical order) of expository text to aid comprehension.</td>
</tr>
<tr>
<td></td>
<td>PO 10: Make relevant inferences about expository text, supported by text evidence.</td>
</tr>
<tr>
<td>C2: Functional Text</td>
<td>PO 1: Use information from text and text features to determine the sequence of activities needed to carry out a procedure.</td>
</tr>
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<td></td>
<td>PO 2: Determine what information (e.g., steps in directions, legend, supplies needed, illustrations, diagram, sequence) is missing in functional text.</td>
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<td></td>
<td>PO 3: Interpret details from a variety of functional text (e.g., warranties, product information, technical manuals, instructional manuals, consumer safety publications) for a specific purpose (e.g., to follow directions, to solve problems, to perform procedures, to answer questions.</td>
</tr>
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### Writing Strand 1: Writing Process

<table>
<thead>
<tr>
<th>Concept</th>
<th>Performance Objective</th>
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</thead>
<tbody>
<tr>
<td>C1: Prewriting</td>
<td>PO 1: Generate ideas through a variety of activities (e.g., prior knowledge, discussion with others, printed material or other sources).</td>
</tr>
<tr>
<td></td>
<td>PO 2: Determine the purpose (e.g., to entertain, to inform, to communicate, to persuade, to explain) of an intended writing piece.</td>
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<td>PO 4: Establish a central idea appropriate to the type of writing.</td>
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<td></td>
<td>PO 5: Use organizational strategies (e.g., outline, chart, table, graph, Venn Diagram, web, story map, plot pyramid) to plan writing.</td>
</tr>
<tr>
<td>C2: Drafting</td>
<td>PO 2: Organize writing into a logical sequence that is clear to the audience.</td>
</tr>
<tr>
<td>C5: Publishing</td>
<td>PO 1: Prepare writing in a format (e.g., oral presentation, manuscript, multimedia) appropriate to audience and purpose.</td>
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<td>PO 4: Write legibly.</td>
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</tbody>
</table>
Writing Strand 2: Writing Components

<table>
<thead>
<tr>
<th>Concept</th>
<th>Performance Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>C2: Organization</td>
<td>Use a structure that fits the type of writing (e.g., letter format, narrative, play, essay).</td>
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<tr>
<td>C4: Word Choice</td>
<td>Use accurate, specific, powerful words that effectively convey the intended message.</td>
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<td>Use words that consistently support style and type of writing.</td>
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<td></td>
<td>Use vocabulary that is original, varied, and natural.</td>
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<td></td>
<td>Use literal and figurative language where appropriate to purpose.</td>
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Writing Strand 3: Writing Applications

<table>
<thead>
<tr>
<th>Concept</th>
<th>Performance Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>C2: Expository</td>
<td>Record information (e.g., observations, notes, lists, charts, map labels and legends)</td>
</tr>
<tr>
<td>C3: Functional</td>
<td>Write a variety of functional texts (e.g., directions, recipes, procedures, rubrics, labels, posters, graphs/tables).</td>
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Language Arts Standard 4: Viewing and Presenting

<table>
<thead>
<tr>
<th>Standard</th>
<th>Performance Objective</th>
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<tbody>
<tr>
<td>Students use a variety of visual media and resources to gather, evaluate and synthesize information and to communicate with others.</td>
<td>VP-E1: Analyze visual media for language, subject matter and visual techniques used to influence opinions, decision making and cultural perceptions</td>
</tr>
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<td></td>
<td>VP-E2: Plan, develop and produce a visual presentation, using a variety of media such as videos, films, newspapers, magazines and computer images</td>
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Science Strand 1: Inquiry Process

<table>
<thead>
<tr>
<th>Concept</th>
<th>Performance Objective</th>
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</thead>
<tbody>
<tr>
<td>C1: Observations, Questions, and Hypotheses</td>
<td>Formulate questions based on observations that lead to the development of a hypothesis.</td>
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Science Strand 4: Life Science

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<tr>
<th>Concept</th>
<th>Performance Objective</th>
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<tbody>
<tr>
<td>C3: Populations of Organisms in an Ecosystem</td>
<td>Analyze the interactions of living organisms with their ecosystems: limiting factors</td>
</tr>
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