The Concept of Systems

2

Instructional Purpose

- To introduce the concept of systems
- To provide students opportunities to describe systems and identify their features

Curriculum Alignment

- ● Goal 1 — Concept
- ○ Goal 2 — Content
- ○ Goal 3 — Process/ Experimental Design
- ○ Goal 4 — Process/ Reasoning

Vocabulary

Boundary Something that indicates or fixes a limit on the size or spread of a system

Elements Distinct parts of a system

Input Something that is put into the system or used in its operation

Interactions Connections made between/among elements and inputs of a system

Output Something that is produced by the system; a product of the interactions

System A group of interactive, interrelated, or interdependent elements that form a complex whole

Materials and Handouts

- Chart paper and markers
- Systems Concept Cards (Teacher Resource 1)
- Systems Vocabulary Cards (Handout 2.1)
- Systems Diagram (Handout 2.2)
- Problem Logs

Lesson Length

45 to 60 minutes (You may want to take a short break between activities 9 and 10.)

Activities

1. Explain to the students that today they will be studying the concept of systems. They will learn what every system has and will observe several systems with which they are already familiar.
2. Model the concept of systems, using a flashlight as an example. Use chart paper and put systems words on display: elements, inputs, outputs, interactions. Ask students to name the important parts of the flashlight, the things that must be there. Elicit responses and list them on the chart paper under *Elements.* Tell students that in a system these are called elements. They are the things that are so important that without them the same system would not exist.
3. Ask students what is put into the system that makes things happen. What are the inputs? List these. Tell students that inputs are the things put into a system to get a result. Next, ask students what we get as a result of using the system properly. List responses on the chart paper under *Outputs.*
4. Finally, explain to students that some *interactions* have to happen in a system. The inputs have to interact with the *elements* to make the system work. What are the interactions for the flashlight? List these on the *Interactions* part of the chart.
5. Tell students that systems also have *boundaries,* the place or borders of the system, such as the outside container that defines/limits the item.
6. Display the **Systems Concept Cards** with the definitions of each component of a system (Teacher Resource 1). Keep these on display for the remainder of the unit.
7. Divide students into small groups. Provide each group with a small model vehicle. Instruct each student to draw the **elements** of the vehicle and label them. Ask students to work together in their small group to develop a thorough list of elements of the vehicle.
8. Next, provide a set of **Systems Vocabulary Cards** (Handout 2.1) to each group, asking each student to take one card. Ask students to take turns in their small group, giving one or two examples of systems components that match their card and explaining why. Ask students to switch cards with someone and repeat the activity. (You may want students to draw pictures of the systems parts on the vocabulary cards.)
9. Make an enlarged copy of the **Systems Diagram** (Handout 2.2) on a transparency or chart paper. Summarize the activity by reviewing the elements, inputs, outputs, interactions, and boundaries of one of the vehicles. Label the enlarged copy of the **Systems Diagram** (Handout 2.2) as you discuss the various systems components.
10. Tell students that there are many different kinds of systems. Some systems are small and it is easy to see their boundaries, elements, inputs, and outputs.

Other systems are more complex, so it is more difficult to identify these things. Some systems contain living things while others do not. Ask students to begin a class list of systems. After a few entries, ask students to work in small groups to come up with more examples of systems and write them on a group chart. As you circulate among groups, stimulate student thinking by asking questions. **Ask:**

- What are some systems in nature?
- What are some systems that people have invented?
- What are some systems in which people play a part?
- What are some systems in which people do not play a part?
- What makes these things systems?
- Can you tell what their elements, boundaries, inputs, outputs, and interactions are?
- How do you decide whether something is a system or not?

11. Encourage each group to share a few examples with the class. Complete a class list of systems. If you find any of the children's responses questionable, discuss the reasoning behind the responses. If you still find them questionable, discard them.
12. Ask students to work in their groups again to put their systems into categories. Use questions to help students in categorizing their systems. **Ask:**
    - How could you separate these systems into different groups?
    - What are some things that a few of the systems might have in common?
    - Once you have put your systems into groups, what would you call each group?
    - Why did you decide that each group of systems went together?
    - Do all of your systems fall into groups?
    - Might some of them belong in more than one group?
13. Ask students if they can think of any examples of things that are not systems. (Examples: a dead leaf, a grain of sand, a block. It helps to understand what a system is when you can also provide non-examples.) Use the terms *elements, boundaries, inputs, outputs,* and *interactions* to discover whether or not something is a system. Some of the things that are not systems may be elements of other systems but not systems themselves. Make a class list of things that are not systems.
14. Summarize the lesson by asking students to record their own definition of a system in their **Problem Logs.** Ask for a few volunteers to share with the class.

Problem Log/Homework

Ask students to draw a system in their **Problem Log,** labeling the elements, boundaries, inputs, outputs, and interactions of a system they know. Tell students

they may select a microwave oven, a bicycle, or some other system they choose. Emphasize the need to label the parts of the system.

Note

Students in the elementary grades tend to look at the qualities of the separate objects in the system rather than considering the function and interactions of the system as a whole. Teachers need to guide students to understand that a system is actually the interaction of parts. Activities in science should help students to see how parts come together to make a whole that has properties that the parts, themselves, do not (*Benchmarks for Science Literacy,* 355–56).

Extending Student Learning

Encourage students to select additional systems for analysis. Instruct them to record each one in their **Problem Log.**

Assessment

- Review student **Problem Logs** to assess their current understanding of systems.
- Gain information about students' understanding of systems by asking these questions about a specific system:
  - What is the function of this system as a whole?
  - What are the essential parts of the system?
  - What are the functions of these parts?
  - Would this device function if one of the elements were removed? Which element could be removed?
  - Could the same basic elements be organized a different way to perform different functions?
  - Is it possible to enhance this device by adding another element?

Technology Integration

Allow students to use Kid Pix® or some other graphic software to create visual representations of systems.

Systems Concept Cards
(Teacher Resource 1)

Boundaries *Something that indicates or fixes a limit on the size or spread of a system*	**Elements** *Distinct parts of a system*
Outputs *Something that is produced by the system; a product of the interactions*	**Inputs** *Something that is put into the system or used in its operation*
Systems *A group of interactive, interrelated, or interdependent elements that form a complex whole*	**Interactions** *Connections made between/among elements and inputs of a system*

Handout 2.1

Name Date

Systems Vocabulary Cards

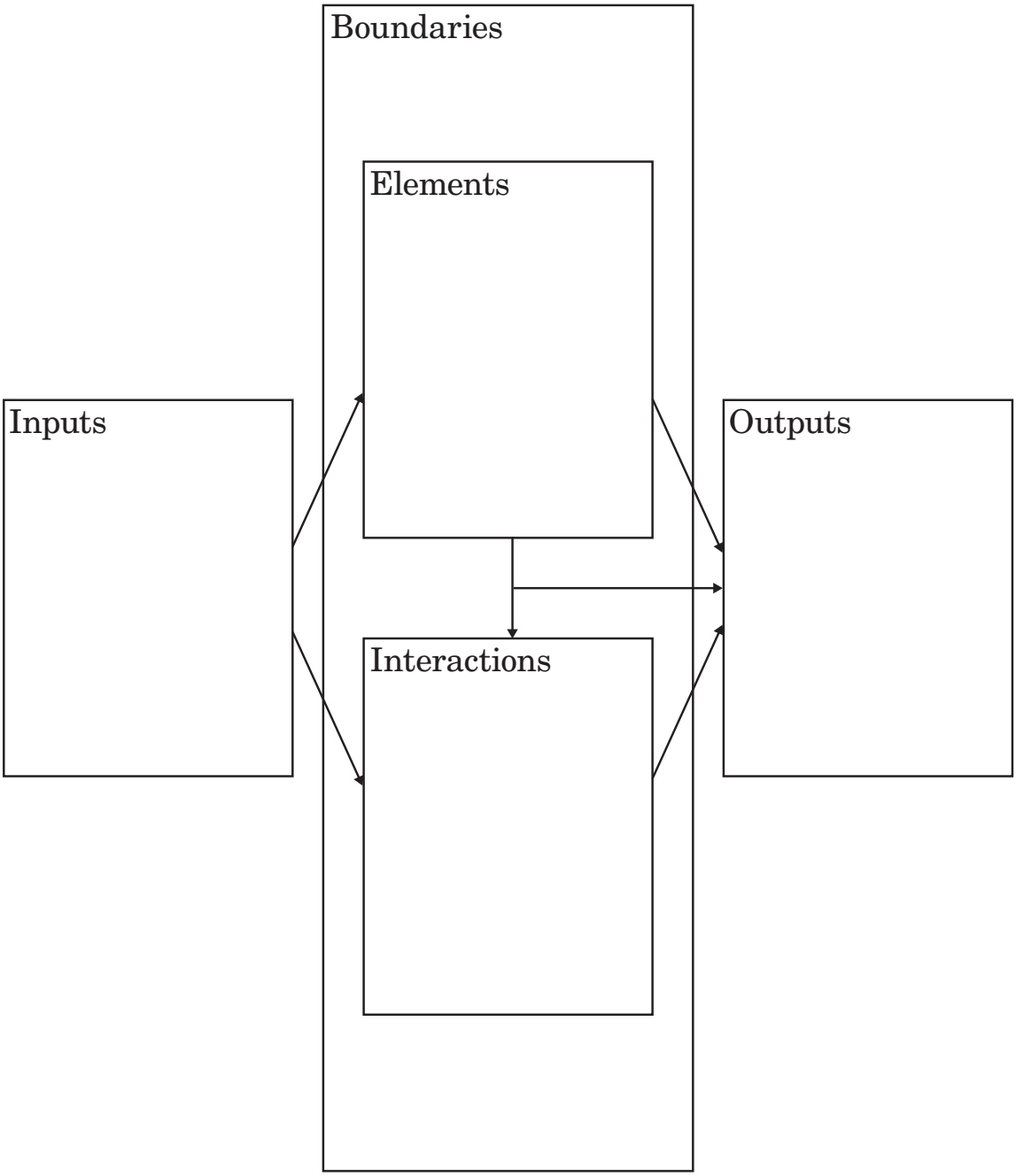
Boundaries	Interactions
Inputs	Elements
Outputs	Systems

Handout 2.2

Name _____ Date _____

Systems Diagram

Name of System _____



Handout 2.1

Name Date

Systems Vocabulary Cards

Boundaries	Interactions
Inputs	Elements
Outputs	Systems

Handout 2.2

Name Date

Systems Diagram

Name of System _____