EarthComm Professional Development Program - Additional Workshop Activities

Introduction

It is most desirable to do activities that are found in EarthComm chapters and illustrate key concepts, lesson design features, and other aspects of the program using those activities as examples. However, in that the concept of systems may be new to some teachers, it may be useful to illustrate that idea using even simpler and more common examples than are found in EarthComm activities. To a degree, this will depend on the workshop presenter's comfort level with the concept as well.

Below are two system analogies that are very much simplified and use common materials so that the general components of a system can be illustrated effectively.

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Water In A Cup

Materials

- Two plastic cups
- Small plastic tub
- Marker
- Plastic wrap Pin

Procedure

1. Fill the plastic cup half full with water, cover it with the plastic wrap and place it in the small plastic tub. Also mark the location of the water level with a marker or piece of tape. The small tub will catch the water flowing out in the next two steps so it does not spill on the floor.

System Analogy
Characteristic parts and properties of the system: The plastic cup, plastic wrap, and the water. A property of this system that can be measured is the water level.
Boundaries of the system: The boundaries of this system are easily defined. The boundaries are: the sides of the glass and the plastic wrap.
Input and Output: There is no input or output. It is a closed system with respect to the addition or subtraction of matter, which is water in this example.

2. Remove the plastic wrap and use the pin to poke a small hole in the side of the cup about one-quarter of the way up the cup. Water should come out of the small hole. You have now created an open system, i.e., matter (water) can be exchanged with the surroundings.

System Analogy
Characteristic parts and properties of the system: The plastic cup, plastic wrap, and the water. The properties of the cup have been modified. A property of this system that can be measured is the water level.
Boundaries of the system: The boundaries are: the sides of the glass and the plastic wrap.
Input and Output: There is no input. Because placing a pinhole in the cup has modified the system, output occurs. Output is greater than input. As a result the system changes. The response of the system is for the water level to go down in the cup. The system is open in that matter (water) is being removed from the glass and added to the surroundings.

3. Fill the second plastic cup with water. Remove the plastic wrap from the first cup and add water to it to bring the water

level up to the initial starting level.

System Analogy
Characteristic parts and properties of the system: The plastic cup and the water. The plastic wrap has been removed. A property of this system that can be measured is the water level.
Boundaries of the system: The boundaries are: the sides of the glass.
Input and Output: There is input and output. Because placing a pinhole in the cup has modified the system, output occurs. The water that is being added to the cup is considered input. To bring the water level back up, the amount of water being added into the system has to exceed the amount leaving the system. Input is greater than output.
Continue to add water to the system so that the water level does not change.

System Analogy
Characteristic parts and properties of the system: The plastic cup and the water. The plastic wrap has been removed. A property of this system that can be measured is the water level.
Boundaries of the system: The boundaries are the sides of the glass.
Input and Output: There is input and output. Because placing a pinhole in the cup has modified the system, output occurs. The water that is being added to the cup is considered input. To keep the water level from changing, the amount of water leaving the system is equal to the amount of water entering the system. Output is equal to input. This is an example of dynamic equilibrium in which the a system is changing (i.e., water is entering and leaving), yet the measurable characteristic of the system (i.e., the water level) remains the same or about the same within limits.
An Earth System Example: The Earth's atmosphere. It is in dynamic equilibrium because the energy received by the Earth from the Sun equals the energy emitted into space. As long as the energy from the sun is constant, and the composition of the atmosphere does not change, the Earth's atmosphere will remain in dynamic equilibrium, and the average temperature at the surface will remain about the same.
Poke at least five more holes into the cup.

System Analogy
Characteristic parts and properties of the system: The plastic cup and the water. The plastic wrap has been removed. The characteristics of the system (plastic cup) have been significantly altered by the addition of the five holes. A property of this system that can be measured is the water level.
Boundaries of the system: The boundaries are the sides of the glass.
Input and Output: There is input and output. Because placing additional pinholes in the cup has modified the system, the potential for output has increased. The water that is being added to the cup is considered input. The output has been significantly increased and the water level is changing. Our dynamic equilibrium has been altered which could lead to detrimental effects.
An Earth System Example: Continuing with our example from step 4, if there is a change to the Earth system such as a change in the Sun's brightness, or in the composition of the atmosphere, the Earth's dynamic equilibrium could change, bringing about a change in global climate.

4. **Alternative Setup:** This analogy can also be done using a large, clear plastic funnel set in a large glass, which will serve to catch the water. The bottom of the funnel could be initially closed with plastic wrap and holes could be punched into the plastic wrap as was done to the plastic glass.

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Card Game System

Card games that are familiar to the participants can be used as analogies to illustrate the attributes of systems. The attributes of a system and the comparison with card games in general and with specific examples are given below.
Characteristic parts and properties of the system: In most card games, there are a certain number of cards that are dealt to each player and there are usually a specific number of players. The total number of cards and the players are considered the system. Each player and the cards they hold are considered subsystems.
Boundaries of the system: Defining the boundaries of the system for a card will be specific to the game being played. Examples of boundaries include: number of cards in the deck; number of card dealt to each player; the number of points being pursued in the card game.
Input and Output: Once a card game starts, it is a closed system. The number of players and cards do not change. However, at the subsystem level, there is input and output. For example, in the game 31 each player is given three cards then it is up to the player to obtain three cards in the same suit whose sum is 31. To accomplish the task of getting 31, each player systematically selects one card at a time. This card is added or input into their hand. Because the system is characterized and defined by the boundary of three cards, the player must discard or output one card from their hand. This is an example of dynamic equilibrium card game in which the a system is changing (i.e., cards are being input and output), yet the characteristics of the system stay the same (i.e., three cards).
In the game "Crazy Eights", eight cards characterize the players' subsystem. The primary goal is to get rid of all your cards through a process of sequentially playing a card that matches those on a discard pile. If the player does not have an appropriate card to play, then they are required to draw from a pile until they obtain a card they can play. Using a systems analogy, the overall goal of the game is for the output to exceed the input of cards. The discard process is the output of cards from the hand. Drawing

from the pile represents the input of cards into the system. Throughout the game the system or number of cards is constantly changing. In some cases, the input can greatly exceed the output so that the player cannot hold all the cards in their hand. The card system is stressed to the point where it exceeds the card-holding capacity of the player and cards fall to the floor.

Feedback: In many card games, the subsystems (players hands) do not exist in isolation. The way in which the cards are played are linked or coupled. For example, in a game of gin rummy, when one player discards a card, the next player reacts to the action of the first player. Their reaction now becomes an action, and the first player reacts to that action. As a result of these couplings, there is feedback between the subsystems. Feedback is a self-perpetuating mechanism of change and response to that change. In terms of change and response, natural and social systems behave in a similar manner.

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