Project: Game-Based Structural Debriefing
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Systems Thinking: Info for Teachers

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Read me: How to use this document

Dear Teachers,

This document provides information that you will need to incorporate systems thinking skills in the ecosystem unit using the Food Fight game as a vehicle to unveil the complexity of an ecosystem.

Hope you find this document useful. Enjoy!

The Food Fight Game

Food Fight is an online educational game developed by the educational game company BrainPOP. Food Fight allows students to build a virtual food web as they learn about coexistence of plants and animals within an ecosystem. Each of the two players selects an animal into the ecosystem and grows its population. Students may add one species to the ecosystem per turn by clicking on the species' card, or they can choose to play a "wild card," which are such events as introduction of poachers or rain. Rather than introducing new species or playing a wild card, students may also chose to simply increase the population of any of the species already in the ecosystem. Rolling over an avatar at the bottom of the game panel reveals information about that species' predators and prey. After a species is added to the ecosystem, status bars around its avatar show how it is doing.

The students should make their species outlast the others. Students should be clear that the objective of each player in the game is to grow the selected animal population.

Resource:
https://educators.brainpop.com/bp-game/food-fight/

There are several options for playing the game: in pairs, as a class and as homework.

Playing Food Fight in Pairs

Form pairs. Each pair starts a game. Have students take turns in selecting species and making strategy decisions.

Playing Food Fight as a Class

Project the game onto a white screen or use an interactive whiteboard. Have students take turns in selecting species and offering one another strategy suggestions.

Playing Food Fight for Homework

Encourage learners to play against friends and family at home, inviting them to share observations of how those outside the "classroom biome" fared.

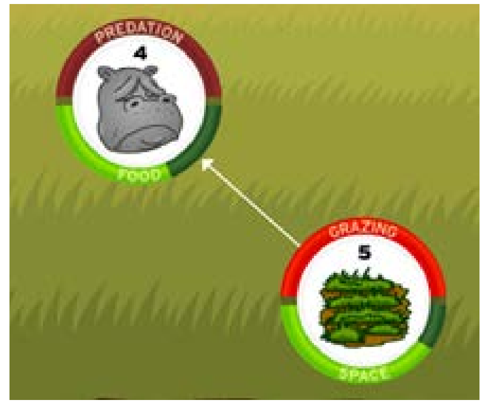
How the game works

There are three things that can change the population of a species between each turn:

1. Food - Does an animal have enough or more than enough food?
2. Space - Does a plant have room to grow?
3. Predation - How much predation does the species face?

Animals need food and plants need space. The net population changes due to these factors can be either positive, negative or zero, as explained below.

Food



Animals want twice as many food units as they have population. In the situation below, the hippos want 8 units of food since their population is at 4. The grass is providing ⅝ or 62.5% of their need so their population will go down by 1. If a population is 1, 2 or 3 then the max growth is 1. The change is based on the percentage of a species' need that is satisfied. The decline in the population occurs according to the following table; the top row shows

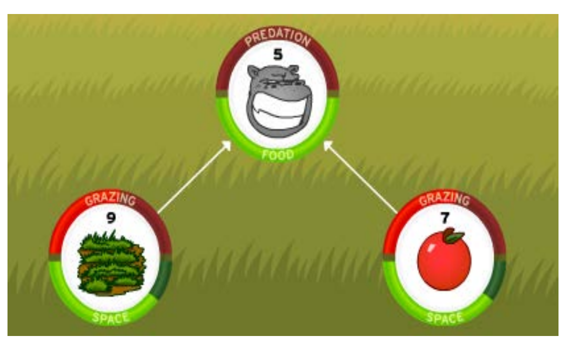
Food supply, % of required	0%	0%--50%	50%--75%	75%--100%	100%
Net change in animal population	all gone	-2	-1	-1	+1

Space

Plants will grow as long as there is greater than zero available 'space units' - up to a maximum plant population of 30. The table below, explains when the plants increase or decrease.

Space available, % of capacity	0%	0-50%	50 - 100%
Net change in plant population	-1	+1	+2

Predation



Species are affected by predation and grazing. The following table show the net rates of change based on the proportion of the plant population as a percentage of total food requirement.

Grazing, for plants:

Plants as % of total food requirement	0-50%	50-75%	75-100%
Plant decline due to grazing	0	-1	-2

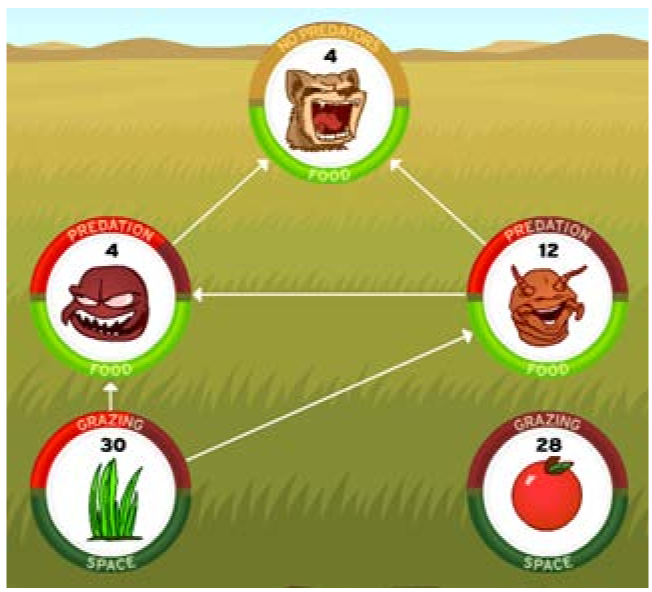
The following table show the net rates of change based on the proportion of the plant population as a percentage of total food requirement.

Animals - predators eating prey:

Prey as % of total food requirement	0-50%	50-75%	75-100%
Plant decline due to grazing	0	-1	-2

Sharing food

Grazers may share plants and predators may share prey. The total of each prey is divided among the predators based on their relative need.



Systems thinking

Source: Richmond, B. (1991). "Systems Thinking: Four Key Questions." High Performance Systems, Inc.

The terms Systems Thinking, A Systems Approach, System Dynamics, Systems Theory, and "Systems" are often used interchangeably (Richmond 1991). We will use the term systems thinking.

- Systems Thinking is a continuum of activities which range from the conceptual to the Technical: At the conceptual end of the spectrum is adoption of a systems perspective or viewpoint. An observer who employes the systems viewpoint sees the underlying web of ongoing, reciprocal relationships which are cycling to produce the patterns of behavior that a system is exhibiting.

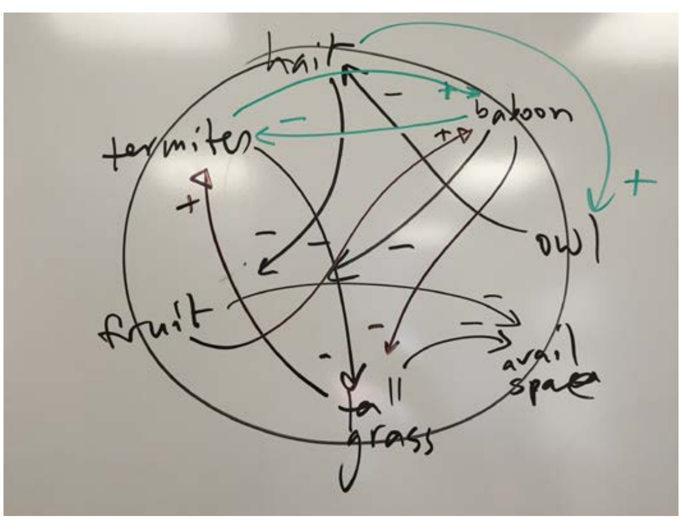
- Moving rightward along the continuum, activities become more concerned with implementation of the viewpoint. As they do, they also become progressively more disciplined and analytical. You might typically begin implementation by developing an influence diagram — a simple map of the reciprocal relationships which you believe to be principally responsible for producing the behavior patterns that a system is exhibiting. These maps basically show what's hooked up to what.

- Next, you might construct a structural diagram. This is a more disciplined map. It attempts to show what really makes a system tick. At this stage of the process, you're laying out the mechanisms you think the system is using to control itself.

- Finally, you might take the step of translating the structural diagram into a set of equations. The equations characterize the nature of the relationships that you laid out in your structural diagram. This activity also includes assigning numerical values to define the direction and strength of these relationships. Completing this step enables you to simulate the system's behavior on a computer. Being able to do this often is very important because it permits you to "close the loop" on your thinking. You can answer the question: Can the set of reciprocal relationships that I've pieced together in fact generate the behavior patterns that are being produced by the actual system?

Systems Thinking Tool: Connection Circle

- A connection circle is a graphical tool for visualizing causal relationships between populations of animals and plants. Connection circles allow students to discover feedback loops within the ecosystem.



Creating Connection Circles and finding embedded loops

(Source: http://www.watersfoundation.org/webed/mod5/downloads/Connection-instructions.pdf)

1. Draw a circle (or use a connection circle template) and write key elements around the outside. You may want to limit the number to 5 – 10, especially when introducing students to the
   technique. Elements chosen should be
   a. a. relevant to the main idea of the story/text/system.
      b. dynamic, i.e. their values change.
      c. nouns or noun phrases, preferably.
2. If desired, create behavior-over-time graphs around the circle for each of the elements.
   Identify causality: elements that cause other elements to change (increase or decrease).
   a. a. Draw an arrow from the “cause” element to the “effect” element.
      b. Label the arrowhead with “+” (indicating that an increase in the first element causes the second element to rise) or a “-” (indicating that an increase in the first element causes the second element to fall). If preferred, use different pencil colors to indicate (+) and (-) relationships.
3. Continue this process until you have represented all desired causal connections. Links may be based on actual data or on hypotheses.
4. Identify and analyze feedback relationships in the circle. To find a feedback loop, look for arrows in sequence that lead back to the original element. These feedback relationships can be
   shown in causal loop diagrams (CLDs).
   6. Tell the “story” of the relationships represented within the connection circle.

Resources:

- What is Connection circle: http://www.watersfoundation.org/webed/mod5/downloads/Connection-instructions.pdf
- Template: https://5thgradewinterhaven.files.wordpress.com/2008/06/connect.pdf