Untangling the Food System

Our food system is complex with multiple inputs/outputs and far reaching implications. It is constantly subject to change and patterns of system dynamics. Thus individual people from diverse sectors are responsible for influencing for the system in multiple ways. The system is closely tied to the environment and issues of social equity.

Students will experience the dynamic, interconnected, nature of systems. To illustrate relationships among components in the system, students simulate system dynamics by moving around in an open space while maintaining an equal distance between themselves and two other people (food system components). Students will explain how their component relates to the others and predict system responses to various “disturbances” - such as drought.

Before beginning, students should: reflect on their prior knowledge about where their food comes from.

Essential Question: ***What are some example components of our food system?***

The objective of this lesson is to experience how components of our food system are interconnected and dependent on one another.

At the end of the lesson, students will be able to:

1. identify major components of the industrialized food system
2. explain how a change in one component can positively or negatively affect a change in another component (cascading effects)
3. propose how they can alter or influence specific components of the food system in order to achieve sustainable solutions/futures.

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Standards Addressed: *Science Strand 1: Inquiry Process, Concept 1: Observations, Questions and Hypotheses; Science Strand 3: Science in Personal and Social Perspectives, Concept 2: Science and Technology in Society, Concept 3: Human Population Characteristics; Science Strand 4: Life Science, Concept 3: Organisms and Environments; Social Studies Strand 4: Geography, Concept 4: Physical Systems; Environment and Society; Concept 5; Social Studies Strand 5: Economics, Concept 1: Foundations of Economics; Mathematics Strand 2: Data Analysis, Probability, and Discrete Math, Concept 2: Probability; Concept 2; Mathematics Strand 3: Patterns, Algebra and Functions, Concept 1:Patterns*

Themes: Systems dynamics, cascading effects, trade-offs

Skills: Teamwork, written communication, oral communication, and evidence based thinking

Key Vocabulary

Food system: *a network of actors and activities that comprise the inputs, distribution, production, marketing, and processing involved in making and delivering food to consumers.*

Direct effects: *in a system, the events caused strictly by one component on another.*

Indirect effects: *in a system, the events caused by one component on another through the actions of one or more intermediary components.*

Cascading effects: *a sequence of events in which each event produces the circumstances necessary for the next.*

Feedback: *the process by which a system is modified by the product/output it creates.*

Dynamic: *characterized by constant change or activity.*

Materials Needed

- **Untangling the Food System Student Worksheet pdf (1 per student)**
- **Untangling the Food System Student Activity Cards pdf (1 card per student or pair)**
- **Untangling the Food System Components and Terms pdf (1 per student or pair)**
- **Materials to make primary food component nametags (1 per student or pair)**
- **One Snickers bar**

Safety Precautions Make sure students have sufficient room to move around without obstacles.

Teaching Instructions

Advanced Preparation

You will need at least 8 students to play. There are 12 Student Activity Cards for each simulation group and students can share cards. Most regular classrooms will form 2 or 3 separate simulation groups. Identify a large open area for the simulation activity such as a gym, hallway, or yard. Cut apart the Student Activity Cards (the Primary Component and the adjacent Interconnected Components). The cards after # 8 must be used in sequence (#9 for 9 players, #9 and #10 for 10 players, etc.).

Optional: Review background information in Additional Resources section.

Engagement

1. Introduction to systems thinking and food: 15 minutes

a. Ask students to remember their last trip to the grocery store. Ask them to consider what effort was needed to produce food. Give examples: Granny Smith apple or Russet potato.

b. e.g. In the simplest way, *farmers* plant seeds and harvest fruit or roots from mature plants. Before the seed is planted, *farmers* may prepare the soils with *fertilizer*. Don't forget the tractors and machines needed to deliver and apply the *fertilizer* or the petroleum that they run on. Once the seed is planted, the plants need *water* to grow and often *pesticides* are applied. When the plant is mature more machines and more *fossil fuels* are needed to harvest our foods before *farmers* can sell their produce. Even simple fruits and vegetables in the grocery store need to be processed, packaged, and transported.

Engagement

2. What about processed foods? Now use a real Snickers candy bar as an example to carefully analyze the production process using a model/diagram on the board. Draw a symbol to represent the Snickers bar.

a. Ask students: What are some inputs of the Snickers bar? Allow them to read the ingredients on the package. Have students identify some of the main ingredients such as milk chocolate, corn syrup, and peanuts. Use these main ingredients for this part of the lesson. Other ingredients can be researched as a possible extension.

b. Guide students to draw symbols and arrows to represent these as inputs to the system. (See the hamburger example model in the resources section to assist you.)

Engagement 3. Guide students to diagram the most complex web of resources and actors that they can. a. Ask the students how *farmers* grow peanuts and what are required as inputs (healthy *soil quality*, *fertilizer*, *fossil fuels*, *water*, etc.). b. More challenging: ask students how corn syrup is produced? Hopefully they will infer that corn is involved and this brings the students to confront how corn is produced.
Engagement 4. As the next step ask: How is the Snickers bar made? a. After the ingredients have been produced the candy bar must be processed, which requires *fossil fuels*. This includes mixing ingredients and packaging. Add these symbols and arrows to the inputs. b. How does the Snickers bar get to our grocery store? Transportation is completed primarily via trucks or trains, which again require *fossil fuels*. c. To finish the model ask students: How do people interact with the Snickers bar? There are two obvious types of actors, which students will encounter again in the next part of the lesson: *farmers* and consumers *(human population*).
Engagement 5. Have the class observe the diagram they created and comment on its attributes. You may say – we have diagramed a system. What do all systems have in common? Systems have many interconnected parts or components that work together - so they are ***dynamic***. a. Ask what is the difference between ***dynamic*** and static? Briefly explore this further: If you change one part, how does it impact others - e.g. what would happen if the demand for the end product, the Snickers bar, suddenly tripled? Some answers include: increased need for processing, which will require more production on the farm, which will increase the need for inputs into the farm. b. If you remove or add something, how does it affect the whole system? e.g. what would happen if *farmers* no longer had access to *fertilizer*?

Exploration 6. Simulation Activity: 25 minutes a. Explain to the students that they are going to do an exercise to further investigate the ***dynamic*** nature of the ***food system***. b. Organize students into groups of 8-12. If you have extra students they can pair up to share an Activity Card. Alternatively, one extra student in each group can act as the “system change agent”, e.g. drought, demand for *organic food*, etc. by following teacher directions to position the students/components appropriately.
Exploration 7. Hand out to each student or pair a Student Activity Card containing one primary food component and the two other interconnected components. a. Have students create a name tag that displays ONLY their primary food component.
Exploration 8. Hand out the Student Food Component and Terms. a. Have a representative student from each Primary Component share it and the explanation with the class. Make sure students understand that each of them represents a part of the food system that depends on the other two components. Whatever happens to one will affect the other two.
Exploration 9. Move to an open space. Each group of students will use 8-12 Student Activity Cards to create a simulated food system. Separate the groups into areas where they can still hear instructions. Pairs of students sharing an activity card may wish to link arms etc. to move in tandem. a. Have students walk slowly among their group members to become equidistant (equal distance apart) from their interconnected components. b. There will be a lot of movement initially and then less movement as time goes on. Have students stop and describe the experience. Were they able to become equidistant from the other components? Was there always some movement? Systems are dynamic and should always have some movement.

Exploration

10. Once everyone has stopped, discuss what would happen if one component was removed or a new component was added?

    a. Ask students: what will happen if the food system experiences a drought? For example, how will the components *food production* and *organic food* be affected? (Allow students to discover in the next steps that they would both decrease. Farm run-off of *fertilizers* and *pesticides* will also decrease if there is less *water* available.)

Explanation

11. System Change #1 - Drought

    a. Instruct the *water* components to move a few feet away from their position and crouch down to represent drought conditions where *water* is scarcer.

    b. After *water* has been moved, instruct the students who are connected to *water* to react and find their equidistance point again.

    c. When they have done so, ask them to explain the impact of drought on their own conditions. Have them crouch or raise their hands to represent a decrease or increase in their components.

    Examples:

    A **direct effect**: *soil quality* – dry soil becomes hard and dense, making it more difficult for plants to grow. Students crouch to show lower quality.

    An **indirect effect**: *food prices* – lack of *water* will reduce *food production*, raising demand and increasing prices. Students raise arms to show higher *food prices*.

Explanation

12. Now have all groups move slowly to become equidistant again and raise their hands or crouch to show their change.

    a. When movement has slowed, ask them to stop. Ask students who have not spoken to explain why they have moved, increasing or decreasing. There are a number of correct answers, encourage some creativity.

    b. Introduce the term **cascading effects**. This describes the system adjustments or **feedback** after a disturbance or change to the system, the sequence of **indirect effects** that fall "like dominos."

    c. When all groups have finished responding you may skip to the reflection or proceed with another system change. Before continuing you may wish to have students answer questions #1 and 2 in response to the first drought simulation. Different groups of students can simulate different disturbances simultaneously and compare experiences afterward.

Elaboration

13. System Change #2: Demand for *organic food* increases

a. Ask students to predict how they think growth in the *organic food* market would impact components such as: *fossil fuels*, *fertilizers*, *pesticides*, *water*, *farmers*, *composting*, *food production*, and *food prices*. Then proceed with the simulation, moving, crouching and raising hands appropriately. Have individual students discuss the explanation for their response and the system outcomes.

Possible effects: Increased demand would lead to more *organic food* production which would increase overall *food production*, require more *composting* and create more jobs for *farmers* and/or farm workers. This extra labor makes the *food prices* of the organic products higher initially. But the question students should ask is: will it also reduce the production of food by more industrialized and high-tech methods? (Recall that many products from industrial agriculture in developed countries become fuels, oils, and livestock feeds, they are not for direct human consumption.[1]) If industrial food is reduced, then the use of *fossil fuels*, inorganic *fertilizers* and *pesticides* would decrease. By its basic definition, *organic food* does not necessarily require more or less *water* than food produced by industrial methods. Organic *farmers may* also make *water* conservation a priority and they may rely more on human labor than machines, such as sophisticated irrigation systems.

Elaboration

14. System Change #3: *Fossil fuel* prices increase

a. Ask students to predict how they think increased *fossil fuel* prices would impact components such as: *fertilizers*, *pesticides*, *soil quality*, *food production*, *food prices*, *water* and *organic food*. Then proceed with the simulation, moving, crouching and raising hands appropriately. Have individual students discuss the explanation for their response and the system outcomes.

Possible effects: *fertilizers* and *pesticides* are made from *fossil fuel*s and can require machinery in their application so their prices could increase, meaning they might be used less and/or they might cause the price of food to increase. Also the cost of *water* could rise; we use *fossil fuel*s to pump *water* and irrigate farms in some areas of the country. All of this would make the price of producing and buying *organic food* more comparable to food that requires high *fossil fuel* inputs, so *organic food* production would increase in the system. This might mean overall *food production* would increase too. However, increased *fossil fuel* prices would raise the cost of transporting food, so all *food prices* would increase. Recall that *organic food* is not necessarily local, although some organic *farmers* may sell their products directly to local consumers.

Evaluation

15. Discussion and Reflection: 15 minutes

a. Guide students to think about where their attention was focused during the activity: on their own actions or the actions of others, on small details or on the big picture? Ask: Why is this perception important? A system cannot be fully understood by examining only one part, but the solutions to large systemic problems also cannot be addressed without examining the individual parts.

b. Ask: Why is it helpful to understand system dynamics and interconnectedness? How does this relate to sustainability? How can this help us figure out possible sustainable solutions?

c. To illustrate ask: What happens if you improve, add, or remove one component? For example, what if you could reduce the impact of drought by:

- Having more *water* reservoirs?
- Growing food products that require less *water*?
- Using less *water* for other purposes?
- Enhancing the ability of soil to hold *water*?

d. Would these changes have positive ***cascading effects*** throughout the system? (This leads easily into the Student Worksheet question #3. Encourage students to think of their own answers.)

Evaluation

16. Hand out Student Reflection Worksheet and have students answer questions in groups of two or independently. (Alternatively, have students complete questions #1 and 2 after the first simulation round).

Extension

17. Optional assessment: have students revisit the original Snickers bar model and copy it on paper. Then ask students to independently revise the model in another color or on another sheet, modifying and adding components, interaction arrows, descriptions, etc. to improve the model based on their simulation experience.

Extension

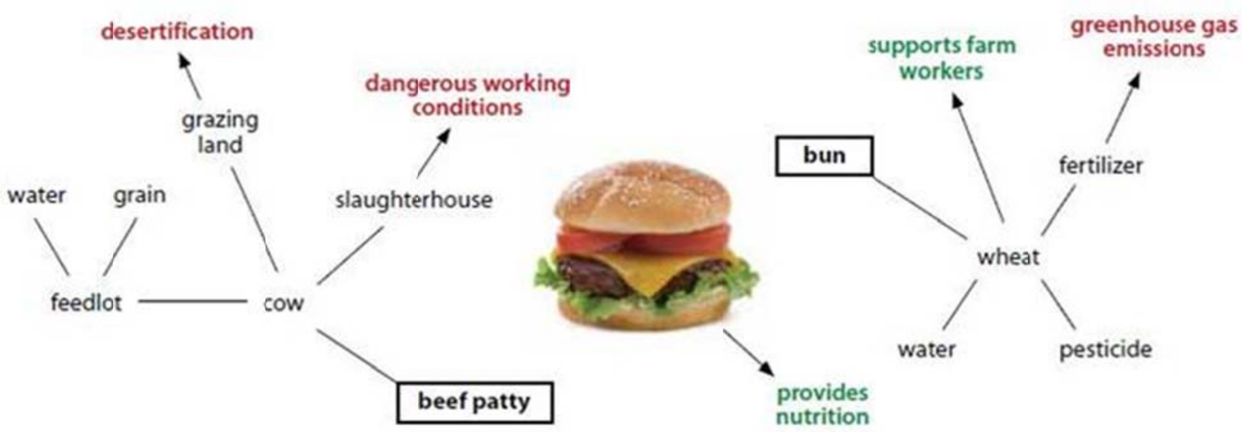
18. Optional discussion, journal, or research question: Today we focused on food systems, what other systems can you think of that are interconnected and dynamic?

Homework

Optional: Have students complete the Student Worksheet or the Extension activities on their own.

Additional Resources

Example: production process model of a hamburger showing inputs



Food Systems: Nourishlife.org provides several useful tools for understanding the industrialized food system. The website maintains a glossary, videos, and downloadable curriculum. http://www.nourishlife.org/teach/food-system-tools/

The Environmental Working Group also provides several useful resources for understanding Agriculture in the U.S. in addition to its relationship to policy. http://www.ewg.org/agmag/

Supply Chain: ASU's W.P. Carey School of Business maintains several introductory videos about supply chain management. Modules 1 (What is SCM?) and 8 (Socially Responsible Supply Chain Management) are particularly helpful. http://wpcarey.asu.edu/supply-chain-management/undergraduate/videos.cfm

Systems Thinking: This lesson is based on a concept illustrated in the volume, The Systems Thinking Playbook by Linda Booth Sweeney and Dennis Meadows. Another great resource for exploring systems thinking is in the Facing the Future curriculum – which teaches about global sustainability issues. https://www.facingthefuture.org/Home/tabid/54/Default.aspx

Fossil Fuels: PBS has an excellent short video on food miles and explains some of the complexity of our current food system with a focus on fossil fuels versus sun-based fuels. Note that some synthetic fertilizers are created with fossil fuels like natural gas to synthesize ammonia as in the haber-bosch process. http://www.pbs.org/e2/teachers/teacher_309.html

References

[1] Lott, M.C. (Oct 7, 2011). The U.S. now uses more corn for fuel than for feed. Scientific American. http://blogs.scientificamerican.com/plugged-in/2011/10/07/the-u-s-now-uses-more-corn-for-fuel-than-for-feed/