Example of a Teacher-created unit: The Commons: Interdependence of Ecological, Social and Economic Systems

Thematic Unit Outline

Background

This unit was an outcome of the 2007 CELF Summer Sustainability Institute. During the intensive week-long institute, teachers gained content knowledge, resources, and strategies to rethink their approach to curriculum and instruction using the lens of sustainability. Guided planning time and one-on-one mentoring at the institute enable teachers to walk away with a unit "makeover" like this one that was implemented during the school year.

Essential Understandings

- *Understand that all elements of a system are interdependent and that the Earth is a series of systems in which we are all a part. (Economic, Environmental (natural), Social)*
- *Recognize they have a role in the system in that they make choices that influence the sustainability of that system.*
- *The mental models that exist and determine their own in a situation as well as understand that they are conditioned to have different mental models which influence their decisions and behaviors.*

Unit Concepts

- The Commons: natural, social, and cultural assets that sustain the community of life
- Concepts that address the interdependence among systems: interdependence, community, systems, relationships, limits, feedback, connections across time and place, balance, unintended consequences
- Concepts that address human behavior, governance and decision-making toward the Commons: policies, rules, rewards/consequences, fairness, civic responsibility, cooperation/competition, motivation, core democratic values, ownership and accountability, and property rights.

Guiding Questions:

1. What is the community of life? Who and what are included?
2. What are characteristics of a system?
3. In what ways do human influence the function of systems?
4. What ecosystem services and natural capital do we rely on? *What can we live without?*
5. How do we define an economic system that reflects the true costs of natural capital and ecosystem services?
6. How do we provide access to these resources in ways that ensure long-term public good and sustainability?

Essential Understandings:

1. a system is a series of inputs and outputs
2. a sustainable system uses waste as food
3. communities include human and non-human members
4. the commons are natural capital like air and water as well as cultural heritage
5. everything comes from the natural commons (i.e. environment)
6. humans are dependent on the commons for survival
7. our dependence on the commons does not mean that it exists for our needs only
8. some aspects of the commons are 'public property' (e.g. clean air to breathe) while others exist in public and private forms (e.g. land)
9. decisions and economic systems affect access to the commons
10. 'Tragedy' of the Commons occurs when there is a lack of social, economic or cultural mechanisms to avoid overuse that benefits the individual at the expense of the collective
11. Laws, community-based trusts/cooperatives and shifting cultural mental models aid sustainability of the commons

Activity 1 **(2 days, single teacher)**

Purpose:

1. Develop awareness of interdependence (a habit of mind) which is vital to the development and practice of systems thinking
2. Experience a shift in perception from individual to team (object to relationship) and relate to an individual as part of a system (ie. Team)
3. Experience and explore how our instinctual tendency to 'go it alone' can create barriers to effectively seeing the interdependencies in systems

Play Silent Squares (game) (see Systems Thinking Playbook page 42 Volume 1 for a version of this game's instructions or handouts in front pocket of CELF binder)

Debrief:

What led to limitation of success (why did it take you so long to get all 4 squares)? [A system will fail if elements…]

Make a list:

- Don't trade enough
- Don't have enough pieces (enough energy/matter/information)
- Keep more than they need
- Don't notice the needs of others
- Become selfish or self-absorbed
- Quit playing/give up
- Don't think/lack skill
- Give too much
- Give away what they need themselves
- Give pieces that other elements don't need

Kids Generate List:

climate
electricity
computers
phone company
human body
nations
money
solar system
water cycle
web of life
ecosystem
trains, busses, etc
relationship
sewage treatment
laws/government
families
our school
sports team
lab group
cafeteria

What are some examples of 'Real World' systems? (Create list, example shown here.) [Where else do you see systems like the one represented by your team in the activity?]

All of the systems listed fit the systems model… you can tease out the parts to whole…

Activity 2 (single day, single-same teacher)
Purpose:

1. Identify that a system is a series of interdependent elements where if one elements breaks down, the system breaks down.
2. Practice art of seeing interdependencies and unintended consequences and shedding assumptions that hinder deeper thought (metal models)

Begin by Thumb Wrestling Activity (pg 22 Volume 1 of Playbook)

Look at the list of systems generated in the Activity 1. Divide into groups and each group chooses one system and create a *web* to show the 'parts' of that system. [Interesting idea is to lead each group to choose a different sports team and see if anyone thinks to include 'givens' like the ball, weather, etc.] Hang up as a gallery walk- giving them an opportunity to add to their posters after they see the other posters. (We might need to define a web by demonstrating that in a web, one element 'depends on' and is linked to a dependent or affected element so that they all follow the same format for comparison purposes.)

Debrief: Review what makes each of these a system? What would happen if one element is removed or added? How did your thinking influence your web and/or how you added elements to the web? Post all 4 class' webs in the cafeteria for a gallery walk.

Activity 3: (Rotate first then multi-day [see below], single teacher)
Purpose:

1. Reinforce concept that nature provides all the resources to maintain life on earth, and absorbs and transforms life's waste into food.
2. Review that living things have life cycles, as do many Earth systems, and products that we use everyday have life cycles too.
3. Become familiar with life cycle of a product in conventional society.
4. Examine the system of inputs and outputs specific to a product and apply knowledge to identify elements that are inputs and those that are outputs and assess balance.
5. Reinforce concept that the environment is both the source of all we need for life, and the sink for its waste. (It is both the input and the output.)

Introduction to Product Life Cycles- The Life Story of a Potato Chip (1 or 2 days)
(See *Designed By Nature*, Lesson 1, page 6-8) ("Designed by Nature" developed by Eastern Michigan University in partnership with Creative Change Educational Solutions)

- Provide a bag of potato chips per group of students and ask: where was this bag of chips before it got to this classroom? And where did they come from? Use the lesson materials provided (transparencies) to illicit responses from the kids to tease out the life cycle and/or have them work in a group to fill in the spaces then share.
- Move into making connections across time and place by providing the kids with the strips of stages of the life cycle and the timeline (taped to the floor). Using the transparencies provided as instructed in the lesson materials (and page 38), students will
    - model the timeline of the life cycle as far as ***when*** they think each stage happened and then guide them through the actual timeline.
    - use the map to identify ***where*** they think each stage took place and then guide them through the actual map

Debrief: Students discuss and summarize the life cycle analysis. Questions might include: What inputs and outputs resulted from manufacturing this product? Are all the outputs equal in terms of environmental effects? What were the environmental effects, and could any be minimized? What other resources were consumed as a result of this product's manufacture and distribution?

Finally ask: What was new or surprising about this activity? Have you ever though about where products come from before? Do you think it's important to think about where products come from? Will you look at products differently now? How so? What considerations do you now have as consumers that you did not have before? Do you see how using less has a huge impact throughout a product's life? Where does the *real* waste occur in the production of these chips- is it what you originally thought of as waste?

Introduction to Product Life Cycles- Manufacturing Simulation (2 days)
(See Design By Nature, Lesson 1, page 9)

- In groups, students will simulate the manufacture of a poster that considers inputs/outputs in the system using a series of incentives related to sustainable materials use and penalties related to waste production. They must design the poster, prepare raw materials, manufacture the poster and then dispose of wastes and are rewarded or penalized for multiple acts throughout each life cycle stage.

Debrief: At the end of the simulation assess using questions (either in class forum, small group share or written) like: What did you find easy or did you like about the activity? What was difficult or frustrating? How did the rewards and penalties affect your behavior in the activity? Give an example where you carefully planned your actions based on the reward or penalty opportunities. If there hadn't been rewards or penalties, do you think you would have paid attention to issues such as how much waste you produced? Why or why not? Did this activity make you think about problems or questions you hadn't considered before? If so, what were they?

- Close with revisit of the relationship between the potato chip life cycle and their simulation experience using the materials provided in the end of the lesson. Students will examine what the inputs and outputs were and compare the manufacture of the chip to the poster including what inputs were used in both products.

Activity 4: (Rotate first then multi-day, single teacher)
Purpose:

1. Reinforce concept that nature provides all the resources to maintain life on earth, and absorbs and transforms life's waste into food.
2. Reinforce concept that the environment is both the source of all we need for life, and the sink for its waste. (It is both the input and the output.)
3. Compare a sustainable (circular and natural) system with one that is human induced and unsustainable (linear).

Begin with Gunter Pauli's Strongest Tree fable (electronic copy in file)

Read fable and then list all of the 'characters' (bees, ants, birds, sun, tree, etc.) in a circle and show connections in a web- is there 'waste', is there 'systems waste'? Can use to go into Waste = Food….What is *waste*? (Need to change mental models of what waste is…)

- Discuss briefly how we tried to 'help' the system with agriculture and industrial agriculture…
- Introduce bathtub flow model – shows that output=input and that waste is used in the system as food…'

Biography of a typical North American Tomato-

- Read "Attack of the Killer Tomato" by Peter Bahouth- The Turner Foundation (in back pocket of CELF binder)
- Show a concept map of the elements that go into the supply and distribution of chain
- Ask, how can we design the chain of *The Tomato* to be more like the one shown by the *Strongest Tree*? (How are they similar, different?)

Revisit the bathtub model – ask the kids to generate a model of the inputs vs. outputs in the tomato example, which should illustrate that there is a significant amount of waste involved in current production/industrial models. [Compare and contrast a sustainable system vs. an unsustainable system.] Ask, how can we design the chain of *The Tomato* to be more like the one shown by the *Strongest Tree*? (How are they similar, different?)

'The tomato system has elements spread so far away from each other! In the days of developing the technologies incorporated here, we were masters of our universe and when energy wasn't an issue, it didn't matter that the places were spread out the tree one is single location oriented! Buy local, buy organic!!'

Give students a copy of the Life Cycle of a CD or DVD poster

*Extension/Enrichment: Life Cycle analysis of Paper vs Plastic Bags or Life Cycle Analysis of the Hamburger Activity

Activity 5: (multi-day lessons [length TBD] with rotation from teacher to teacher)

Purpose:

1. Explore the inputs and outputs of a system in a more complex global context (climate change, Easter Island, *The Lorax*)
2. Continue reinforcing systems thinking concepts of interconnectedness and balance and introduce the concept of unintended consequences and the pitfalls of overusing natural or common resources.

Math: *Explore mathematical applications of global warming data to assess evidence and draw conclusions about trends related to cultural choices.*

Begin discussion on global climate change and look at the graphs of data presented. What is a graph? Look at different graph examples and discuss linear vs. nonlinear patterns using TI-84 graphing calculators in the context of climate change relationships like temperature and carbon emissions and population. Analyze the math involved in the input/output model Climate Challenge: Our Choices Global Warming simulator/bathtub model of INPUTS and OUTPUTS (the course of gas increased over the course of many years with continual increase in CO2,

decreasing CO2, or leveling off levels- the fact that we need to have 56% reduction in emission levels in order to maintain the natural source/sink systems). Look at oil consumption and calculate 'years of oil' left- alternatives including biodiesel and other renewable sources. Are they sustainable?
Then go to calculating Years to the End of Oil - Where have all the gas stations gone? (found in CELF binder, last section in files) (There is a Peak Oil article in Scott's stuff on computer.)

Global Reserves (trillions of barrels)		**Global Consumption Rate**			
		0%	1.7%	3.5%	5%
	2 (med. low estimate)	66	45	34	30
	4 (high estimate)	133	70	50	41
	20 (impossible)	667	148	92	72

Which is a better deal? Reduce consumption and use renewable resources…

Science: *Investigate the science of the greenhouse effect and global warming and look at conclusions of the scientific community.*

Begin discussion on global climate change and introduce greenhouse effect science with animation. Share with students demonstration of greenhouse effect and additional information that illustrates the balancing system that maintains Earth's constant temperature naturally. Discuss causes and effects of global warming (calculate our carbon footprint) Show and digest clips from Inconvenient Truth about climate science and share findings of IPCC. Ask questions like: Is the global climate changing? Is the world getting warmer? What evidence do we have? What impacts are quantitative and which are qualitative? Analyze relationship between our actions and global climate change and review system thinking concepts of unintended consequences of industrialization using the input/output model of Climate Challenge: Our Choices.

English: *Draw connections to current social and environmental issues from metaphorical children's literature.*

Read through "The Lorax" (See pg 88 in When a Butterfly Sneezes for details) with the class (or in small reading groups) and ask questions to pull out the systems thinking goals that we want the students to understand:

- What happened in the story?
- Why do you think the Once-ler and his family didn't realize what was happening to the forest?
- How can we learn to better see and anticipate what is happening around us?
- If you could visit the Once-ler, how would you help him better take care his Thneed business? What would you tell him to do, if he could start over again?

Follow with "Wump World" by Bill Peet and/or "Yertle the Turtle and other Stories" by Dr. Seuss in small reading groups to explore similar systems thinking concepts. Perhaps write a short story?

SS: *Examine the historical events that led to the downfall of civilization on Easter Island and infer the metaphorical lesson that applies to current cultural issues of un-sustainability.*

Lesson Suggestion: History of Easter Island (pp available in files) as a metaphor for future change (see below) – the idea that the culture continued to degrade its environment without regard for the non-sustainability of their actions- cutting down the forests to make platforms to move statues but eventually cut down so many that none were left for canoes and the inhabitants were trapped on the island.) Draw connection of the historical link between industrialization and climate change and social/cultural choices

Easter Island (metaphor for current change…)

- The original inhabitants were probably Polynesian or Peruvian
- History of island as most accepted shows crash of the population of people from 5th century common time to 1870's when only 110 people were there from 7,000 or so max pop
- Moai (statues)- 288 of 887 made it to designated platforms, 397 still in the original quarry and the rest were left 'in transit' and abandoned…question is why….
- One section (Ahu Tongariki) was excavated and restored- debate as to why/should we restore them or let them go…
- How did they move these statues into place back then? Answer lies in the ecological past-

  - Island is deforested- pollen cores shows history of the tree pop decline
  - Hauled them on wooden platforms vertically (probably)
  - Charles Love, geologist proved you could move them with only 2 people in only a few minutes several hundred feet using the wooden platform theory (see Nova Online)
  - Caloric expenditures of statue movers was probably huge and 100's would move them- need food…deforestation for cropland?
  - Society overused the resources on the island to support cultural beliefs and norms and destroyed their own society (palm forests cleared was a subtropical forest with this palm that would provide canoes, building materials etc.) By 1600, soil dried b/c of deforestation
  - Streams/drinking water dried up and topsoil eroded, grass fueled the only fires b/c there was no wood, no rope then either so they were trapped
  - In 1722, Europeans discovered island and reported that the islanders are cannibals; rats ate the seeds so regeneration of plants was so slow!
  - Deforestation more severe on dry, cold, high-altitude islands, old volcanic islands, islands with aerial ash fallout, islands far from Central Asia's dust plume, low islands, remote ones that are small
  - 1400 – Palm extinct, no porpoise bones present at that point archaeologically so they lost that food source by then

"What was the last person thinking when they cut down the last tree?"