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Common Tragedies: Concepts in Cross-Border Sustainability

Lesson plan for grades 3-5
Length of lesson: 1 Class Period (60 minutes)
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SOURCES AND RESOURCES:

- A summary of Hardin's The Tragedy of the Commons http://faculty.wwu.edu/gmyers/esssa/Hardin.html
- Greenpeace International- Overfishing http://www.greenpeace.org/international/en/campaigns/oceans/overfishing/
- Dr. David Orr's Hot Science – Cool Talks Lecture about Black Swan Events and Sustainability (for teacher reference) http://www.esi.utexas.edu/k-12-a-the-community/hot-science-cool-talks/black-swans-a-the-us-future-creating-sustainable-a-resilient-societies

POTENTIAL CONCEPTS TEKS ADDRESSED THROUGH THIS LESSON:

§112.14 b: 1AB, 2ADF 7BD
§112.15 b: 1AB, 2ADF 7C
§112.16 b: 1AB, 2ADF 7C 9C

PERFORMANCE OBJECTIVES (in order of increasing difficulty to permit tailoring to various age groups):

Students will be able to:

- State the differences between non-renewable and renewable energy sources.
- Identify and simulate several global resources that societies and countries need in order to survive
- Identify wasteful use of resources and a more conservative/sustainable use of resources and the outcomes of each process on the resource supply

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MATERIALS (per group of four): (Numbers may be adjusted based on class size and budget)

- 50 Goldfish – Representing Fisheries ("technically" renewable, but due to overfishing this resource will be limited in its renewability)
- 50 Lima Beans – Representing Vegetable-based Food (renewable resource)
- 100 M&M's- Representing Oil (non-renewable resource)
- 50 Skittles- Representing Solar Energy (renewable resource)
- Pencil and Paper for each student
- A die
- **Paper towels (for sanitary conditions)**
- Worksheet (One per student)

CONCEPTS:

Non-renewable refers to something that cannot be replaced nor replenished (such as fossil fuels).
Renewable Energy refers to something that can be replaced over time, such as crops, tidal energy, wind energy, solar energy, etc.

To be **sustainable** means to be able to supply our needs today without harming future generation's needs.

BACKGROUND:

An important issue facing today's population is the lack of resources to provide for everyone on the planet. Running low on oil is by far the most famous example of this, but there are plenty of other examples of humans using up non-renewable resources that will eventually run out. It is important for society to become **sustainable**, to be able to conserve an ecological balance by avoiding the depletion of natural resources. This not only means switching to renewable resources, but managing those resources in an effective manner so that they do not become non-renewable.

The activity itself is based off on Hardin's The Tragedy of the Commons, linked in this paper. The book illustrates the problems with letting everyone grab what they want without regard for others. The "Commons" talked about in the passage refers to shared resources from which different groups draw from that has no particular boundary or property definition. Because of this global resources are generally viewed from a more "it belongs to me" attitude that overlooks the fact that the resource itself is finite. This also leads to the effect that these global resources generally lack a cohesive, coordinated management system. The very first example will illustrate this. It is recommended to read the summary to learn the basics of it and refer to it if time permits.

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Rare, large scale, events that come as a surprise and has a devastating impact to the environment or natural and human systems are known as "Black Swan" Events, which are also illustrated in the Explore section.

PREPARATION:
Have the material laid out on the tables before the class arrives to save time, but make sure no one touches the materials before it is time for the Explore.

ENGAGE: (10 minutes)
The purpose of the Engage is to get the students to think about resources
Ask:

- Who can tell me what a resource is?
    - What type of resources do you use every day?
- Are some resources more important than other types? If so, which ones and why?
- Are there some sources that will run out eventually? If so, which ones?
- Are there some that we can replenish with time? If so, which ones?
- How do you share a resource that you and your neighbor need?

EXPLORE: (30 minutes)
This lesson uses an engaging game to show students the importance of having a sustainable nation in order to survive. The Numbers may be adjusted depending on class size, available resources, budget etc. at the discretion of the teacher. There are a number of ways to implement the activity depending on the time and the teacher, however it is essential to at least do one of each of the three scenarios. It is important to go over the rules of the game beforehand to explain to students how this relates to the real world.

Each student represents a country, and each group represents a group of countries that are forced to share the same resources. You may either randomly assign students the designation of small, medium or big country or manually assign it, but it is important for each group to have at least one big country.

The goal of the game is to survive the longest amount of "years" which represent a round. Each student needs so many resources to survive a year, based on their size (numbers may be adjusted as needed)

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Small Country: Need 4 food and 4 energy to survive a year
Medium Country: Needs 5 food and 5 energy to survive a year
Large Country: Needs 8 food and 8 energy to survive a year

Each resource represents a certain amount of food or energy that they contribute.
Oil: Represented by M&M's represents 5 energy, however it is used up per year
Solar light: Represented by Skittles, only provides 2 energy but is renewable so it stays each year for 5 years.
Fish: Represented by Goldfish, counts for 5 food however is used up per year
Veggies: Represented by Lima Beans, counts for 2 food but is renewable so it stays each year for 5 years.

Basically, one unit provides x amount of energy or y amount of food. 1 M&M represents 5 energy units. 1 Skittle represents 2 energy units, however during the 5th year it is "consumed" to represent that even renewable resources will decay (solar panels get damaged from weather, farms need to be re-ploughed/overhauled, etc…) and need to be maintained/replaced from time to time.

After each year, groups will first "dispose" of their resources onto a separate paper towel, not mixing up the various resources. This way the group can reuse the resources for future scenarios.

Then, go around and distribute new "resources" for each group (depending on events and scenario). This represents our ability to gather new resources while using up what's available, but certain events may hamper this (see below).

Finally, we have the "Black Swan" Die, where the events are unpredictable and are negative . At the end of each year, the groups will roll the die to determine what happens that year that effects the resources. The Events differ for each scenario, so they will be shown during each scenario.
Make sure that this information is available for all students to refer back to during the game (like on a board or DocCam).

The resources listed in the resource section represents how much each group starts with each scenario. Numbers may be adjusted as needed, but keep the oil resource high to represent it as the major source of energy.

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Scenario 1: Tragedy of the Commons

This activity reflects The Tragedy of the Commons and what happens when people don't think ahead or about anyone else.

There are no restrictions on this activity as far as how many one person can take. The person who is the big country goes first, as the bigger country (with a larger population) needs more resources than smaller militaries, and can take as much as they want/need per a year. Afterwards the middle and then the smaller countries take what they need to survive the year. (In the case of multiple of one type of country, let them solve it with Rock Paper Scissors or at the discretion of the teacher).

At the end of the year, let the group roll the die and the following event will happen:

1 or 3 Oil Spill! The supply of oil has been hit from an unfortunate accident at an offshore drilling platform! Deplete 10 M&M's from shared resource.
2 or 4: Fish Disease! The Fish supply has been tainted by a virus and depletes 10 fish from shared resource
5: Acid Rain: Acid Rain has contaminated the soil that could have been used for farms! Loose 5 lima beans from shared resource
6: Earthquake: An earthquake ruins the land set aside for solar energy! Loose 5 Skittles from shared resources.

(The above can be modified as needed).
Every year, give each group,3 Lima Beans, 3 Skittles and 2 fish (no M&M's because that resource is not re-newable in a realistic human time scale).

Ultimately the game ends when everyone dies from lack of either resource. A possible variation is to make energy less necessary then food by allowing the country to survive even if it runs out of energy, but it has to make up the difference with food.

Let the students record what happened to them on the worksheet

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Scenario 2: A Modern Dilemma

The Second Scenario depicts more of what happens today. Thanks to regulations imposed by countries and the UN, there are now restrictions on what can and can't be done with gathering resources. While it helps prevent the tragedy of the Commons, it doesn't help with surviving for too long.

Before the activity begins, let the groups decide just how much each country is allowed to take. Ideally the students should allow for each country to take whatever they need and leave the others alone, but depending on the events used some may allow for taking extra in case of fish disease or Acid Rain.

The goal of this game is to see which group in the class lasts the longest, not just which within the group can last this longer. This promotes everyone to work together to survive as long as possible. Winners can be determined based on how long an entire group of 4 lasts, a group of 3, etc.

Events for the Black Swan Die:
1 or 3: Oil Spill! The supply of oil has been hit from an unfortunate accident at an offshore drilling platform! Deplete 10 M&M's from shared resource.
2: Fish Disease! The Fish supply has been tainted by a virus and depletes 10 fish from shared resource
4: Acid Rain: Acid Rain has contaminated the soil that could have been used for farms! Loose 5 lima beans from shared resource
5: Earthquake: An earthquake ruins the land set aside for solar energy! Loose 5 Skittles from shared resources.
6: Nothing bad happens.

Note that the events aren't quite as bad as before, and now there's some benefits to keeping resources in the shared pile rather then collecting them all at once:

Oil: As before, Do not give any since it is a non-renewable resource. It should be noted that in this scenario Peak Oil is assumed to have occurred.

Fish: The more fish that are left, the more fish there are to reproduce, so give more fish to those groups with more fish in the resource pool. Ex: If there are 30 fish in the pool, give that group 8 compared to a group that only has 10 which only gets 3

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Farmland: Farming uses up nutrients if the same crop is grown over and over in the same spot. By leaving some land alone, nature can help restore these nutrients, so give an increased amount of beans for larger unused plots (5 for 20 lima beans left over for example)

Sunlight: No benefits for not using sunlit land, 3 per turn.
Let students record their results on the worksheet (see Materials Section).

Scenario 3: Sustainability
This is where we want to be, a sustainable group that can survive Black Swan scenarios. By now the students should realize it's far more beneficial to use solar energy and farming then the fish and oil, so this scenario helps to emphasize this by letting Solar Energy and Farming count for 3 for energy and food (respectively).

The goal again is for each group to last as long as possible, but this time everyone has to survive. If one person falls then the entire group is out, so this definitely encourages policy with the group on who can take what before the game starts.

Black Swan Events also have less impact to demonstrate how a sustainable society can help to lessen the impact of these events.
1 or 3: Peak Oil hit. This means that the groups oil reserves have been tapped out and will not receive more oil for the remainder of the scenario (If the group rolls this again, have it become an oil spill and loose 10 oil from the shared resource)
2: Fish disease: The fish supply has been tainted, but luckily thanks to sustainable fish farming the disease is quarantined and only effects 3 fish
3: Acid Rain- Thanks to a sustainable society that reduces carbon emissions, Acid Rain is not nearly as deadly and only takes away 2 farms.
4: Earthquake- Some events can't be overcome even with the best sustainable society and earthquakes are one of them. Loose 5 skittles.
5 or 6: Nothing bad happens.
(Note do not actually tell WHY the numbers have changed for Black Swan Die, let the students explain why during the Explore)

Let the students record what they observed on the worksheet

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EXPLAIN: (15 minutes)

Let the students present in groups what they saw happen with each scenario and which one they thought was the easiest to survive the longest and why. Ask probing questions about specific parts of the scenario and what the students think they mean.

- Do you think that the fish count as a renewable or non-renewable resource?
  - Could there be a reason why the fish aren't renewable like the farms are?
  - Do you think there's a way we can make the fish a more renewable resource
- Did you notice any difference between the Black Die Events during each scenario?
  - What specifically was different, and why do you think it changed?
- Why do you think the oil gave more energy than the solar panels?

ELABORATE: (15 minutes)

After the presentations, go over with the students that Sustainability is the ability to endure over a long period of time (spanning several human generations), and that in an economic sense it means being able to survive these Black Swan Events and able to keep on surviving even when resources run low. It also means preventing the "Tragedy of the Commons", where people overextend how much resources they take so that others don't get it and renewable resources can't keep up with the high rate of demand. Explain to the students the basic idea of the "Tragedy of the Commons", using the sheep pasture example to illustrate what happens when there are no restrictions put on resources and when people only think about themselves and not each other or the environment.

Let the students come up with ideas on how renewable resources that can be used as opposed to non-renewable ones, and ways we can keep our renewable resources without using them up too quickly

EVALUATE: (10 minutes)

To check for understanding, have the students record their responses to the following questions in their journal either in class or for homework:

1. List at least two forms of **non-renewable** and renewable resources
2. Explain the difference between renewable and non-renewable resources
3. What ways can we keep our renewable resources without using them up too quickly?
4. What are some things we can do as a class to help build a more sustainable society?

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Sustainability Worksheet

Name:
Group Name:
Country Size:

Scenario 1:
How many years did your country survive?

Who survived the longest? Why do you think they survived the longest?

Do you think this was a fair event? Why or Why not? How could you make it fair if it wasn't?

Scenario 2:
How long did your country last? Your group last?

What rules did you agree to before the event started?

Were resources shared better?

What did you notice about the resources in terms of how fast they ran out for each country during the event?

Do you think the events on the Black Swan Die are good or bad? Can you name some events similar to the ones on the Die that may impact resources?

Scenario 3:
How long did your group last?

Did you notice anything different from impacts from events created by the Black Swan Die this time compared to the previous scenarios?

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Did your last longer than the previous scenarios? Why do you think that is?

Which resources were more important in the long run? Do you think there's a connection between the two types of resources (renewable vs. non-renewable)?

Which of the three scenarios did you think was the most fair for everyone?