5-Day Tragedy of the Commons & Fishing Game Lesson

The tragedy of the commons was initially proposed as a hypothetical model to illustrate a much larger societal problem. In colonial times, there was often a common pasture (the "commons") where all citizens of the town could take their livestock for grazing. In the tragedy of the commons each individual farmer and their animals use this pastureland to derive the maximum benefit possible. As more animals use the resource, the pasture gets trampled and overgrazed until there is no grass left. If each farmer simply uses the pasture as much as possible then the resource is destroyed.

This lesson focuses on a present day tragedy of the commons. Many of the world's fisheries are overfished and have collapsed or are on the verge of collapse. This activity helps students recognize the problem by catching fish (crackers) from oceans (reusable bowl). Students will spend 8 years fishing in their oceans. To mirror real-world situations where individuals can pursue self-interests and subsequently ruin the commons, there is also an individual prize for any fisherman that catches a large number of fish. However should the students choose to pursue the bigger individual prize, the game is designed so that the fishery will crash. At the end of the game, some oceans will likely have over-harvested their stock until there are no fish left. Others will have developed a strategy in order to maintain a sustainable fishing industry. The stage is then set for solid discussions of resource management strategies for other shared environmental resources.

This lesson plan is split into five mini lessons:

Day 1: Introduction
Day 2: First Fishing Game Play-Through
Day 3: The Tragedy of the Commons
Day 4: Second Fishing Game Play-Through
Day 5: Finishing up and Reflections on the Fishing Game

*Note: Wikipedia has a wonderful summary of the tragedy of the commons (http://en.wikipedia.org/wiki/Tragedy_of_the_commons). It includes an excellent review of Hardin's original essay on the topic, historical background about the origin of the concept of the commons, and examples of modern commons problems: littering, air quality, water quality, population growth, logging, etc. Another great resource to look over before conducting the lesson is PBS's *Fishing for the Future* (http://www.pbs.org/emptyoceans/educators/activities/fishing-for-the-Future.html). The fact sheet used in this lesson plan is taken directly from this resource.
Download Hardin's original article here

Essential Question: How have people impacted ocean ecosystems over time?

The objective of this lesson is for students to gain background knowledge about the ways that people interact with ocean ecosystems.

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

1. *Describe the current status of global fisheries.*
2. *Explain how fish get into the food system.*

Standards Addressed: *Science Strand 1: Inquiry Process, Concept 1: Observations, Questions and Hypotheses; Strand 3: Science in Personal and Social Perspectives C 1: Changes in Environments PO 1. Evaluate how the processes of natural ecosystems affect and are affected by humans PO 3. Assess how human activities can affect the potential for hazards (e.g. cutting down mangrove forests for prawn production reduces natural breakers of tsunami effects). PO 5. Evaluate the effectiveness of conservation practices and preservation techniques on environmental quality and biodiversity.*

Themes: Systems dynamics
Skills: Evidence Based Thinking

Key Vocabulary (dictionary.reference.com)

Industrialized: to introduce industry into (an area) on a large scale
Livelihood: a means of supporting one's existence, especially financially or vocationally
Video Sonar: a visual method for detecting and locating objects submerged in water by echolocation. What animals use sonar?
Mangrove Forests: any tropical tree or shrub of the genus Rhizophora, the species of which are mostly low trees growing in marshes or tidal shores, noted for their interlacing above-ground adventitious roots.
Overexploited: to over utilize, especially for profit.
Aquaculture: the cultivation of aquatic animals and plants, especially fish, shellfish, and seaweed, in natural or controlled marine or freshwater environments.

Teaching Instructions

1. Steps 1-4 can be used as a short stand-alone exercise. Begin class with a brief *pre-quiz* based on the "Fishing for the Future" worksheet. Have students record their answers on the quiz forms that can be printed in the Excel document.
2. View Answer Key to the quiz questions found on the last page of the CommonsHandouts document (DO NOT DISCUSS ANSWERS WITH STUDENTS AT THIS TIME).
3. Collect quiz forms and record scores in the excel document (automatically produces charts that summarize the class statistics on the quiz).
4. Conduct a brief discussion of fishing. What kinds of fish do you eat? What do you know about where fish come from and how they are caught? Who has ever gone fishing before? (about 5 minutes).
5. Organize students into groups of 3-4 and distribute copies of both Day 1 worksheets to

each student.

6. Have students take 5 minutes to read the "Fishing for the Future" worksheet individually.
7. Next have students fill out the "Sum it Up" worksheet as a group.
8. After about 5-10 minutes go around the room and have each group report 2-3 of their top 20 words that they used to sum up the fishing worksheet. Continue until all unique terms are presented. Be sure to ask students if they know the definitions for all Vocabulary terms listed above. Gather ideas and then give the dictionary definition.
9. As the groups report out write the terms on the board and make marks next to words that were repeated by multiple groups.
10. Distribute Tragedy of the Commons Day 2 Worksheet Part 1 and Rules handout to each student. The handout contains the rules to the fishing game that will be played on day 2 of the lesson. Go over the rules to the game and answer questions.

Homework: N/A

FIRST FISHING DAY (50 minute lesson)

Essential question: How have people impacted ocean ecosystems over time?

The objective of this lesson to understand ways in which people manage resources

Image by Bern Altman

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

1. *Graph changes in a population over time.*
2. *Describe different ways to manage a resource (sustainable versus unsustainable)*

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. Math HS.S-ID.1. Represent data with plots on the real number line (dot plots, histograms, and box plots). HS.S-ID.2. Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.*

Themes: Systems Dynamics, Cascading Effects
Skills: Quantitative Skills, Problem Solving Skills

Key Vocabulary

Population: the number of a specific type of organism living in a given area.
Natural Resource: anything used by people to meet their needs including air, water, minerals, plants, fuels, and animals.
Common Pool Resource: a natural resource that people are normally free to use.
Fishery: refers to the activities involved in catching a species or fish or shellfish or a group of species that share the same habitat.
Overfishing: fishing to the point where the fishery collapses or can no longer sustain the catch.
Carrying Capacity: the maximum, equilibrium number of organisms of a particular species that can be supported indefinitely in a given environment.

Teaching Instructions

1. Introduce today's activity. Students will become fishermen and women for the day (See handout for game rules).
2. Have students form groups of 4.
3. Pass out the handout with the rules, data tables, etc. Have one person from each group collect a bowl, 4 spoons, and 4 napkins for the members of their group.
4. Have students answer the background questions on the Part 1 and Rules handout. After about 5 minutes have the groups confer on what the answers are to each question.
5. Now prepare to play the fishing game. When all groups are ready, the teacher should say "GO" and give students 20 seconds to fish. When the teacher says "STOP" all fishing poles must be put down.
6. Students should fill in their data tables with the number of fish that remain in the ocean, the

number of fish in their catch, the number of fish caught by each fisherperson in their group, and the total fish caught. Once their tables are filled out, they can eat their catch!

7. As they fill in the tables, go around and adjust the number of fish in each ocean for the next round. For every ten fish left, add four more fish to the ocean.
8. Have students work on part 1 of the worksheet questions at this time.

THE TRAGEDY OF THE COMMONS (50 minute lesson)

Essential question: How have people impacted ocean ecosystems over time?

The objective of this lesson is to understand "the tragedy of the commons"

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

1. *Devise possible strategies to manage natural resources by using experiences from the fishing game.*
2. *Apply math skills to real world problems.*

Standards Addressed: *Geography C 5: Environment and Society PO 4. Analyze the environmental effects of human use of technology (e.g., irrigation, deforestation, overgrazing, global warming, atmospheric and climate changes, energy production costs and benefits, water management) on the environment*

Themes: Trade-offs
Skills: Quantitative skills

Key Vocabulary

Tragedy of the commons: dilemma where individuals acting in their own self-interest will deplete a resource. Original source is an essay in the journal *Science* (1968) by Garrett Hardin which can be downloaded here.
Resource Management: ways to allocate resources to interested parties so that the resource will be sustained over time.

Teaching Instructions

1. If needed, allow students to finish completing the Part 1 section of the worksheet.
2. Present the Tragedy of the Commons PowerPoint introduction.
3. Have students brainstorm solutions to some commons problems in their groups related to the fishing game and reflect on how the game play went the previous day.
4. Give each group time to discuss possible solutions to playing the game in a way that is more sustainable. They will be playing again tomorrow and they are allowed to strategize as a group if they choose to.

Homework: N/A

Day One
Day Two
Day Three
Day Four
Day Five

Created by Brendan Denker

SECOND FISHING DAY (50 minute lesson)

Essential question: How have people impacted ocean ecosystems over time?

The objective of this lesson is to show how collaborative decision-making may improve the longevity of a natural resource?

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

1. *Apply strategies for maintaining fish populations.*
2. *Calculate fish stocks over time.*

Standards Addressed: *Science Standards Strand 1: Inquiry Process C 2: Scientific Testing (Investigating and Modeling) PO 5. Record observations, notes, sketches, questions, and ideas using tools such as journals, charts, graphs, and computers. C 5: Communication: PO 2. Produce graphs that communicate data. (See MHS-S2C1-02) PO 3. Communicate results clearly and logically.*

Themes: Systems thinking
Skills: Team skills

Key Vocabulary

No new vocabulary

Teaching Instructions

1. Pass out the Part 2 data tables and handout. Have one person from each group collect a bowl, 4 spoons, and 4 napkins for the members of their group.
2. When all groups are ready, the teacher should say "GO" and give students 20 seconds to fish. When the teacher says "STOP" all fishing poles must be put down.
3. Students should fill in their data tables with the number of fish that remain in the ocean, the number of fish in their catch, the number of fish caught by each fisherperson in their group, and the total fish caught. Once their tables are filled out, they can eat their catch!
4. As they fill in the tables, go around and adjust the number of fish in each ocean for the next round. For every ten fish left, add four more fish to the ocean.
5. Have students work on Part 2 of the worksheet questions at this time, including some or all of the analysis questions.

Homework: N/A

Created by Brendan Denker

FINISHING UP AND REFLECTIONS (50 minute lesson)

Essential question: How have people impacted ocean ecosystems over time?

The objective of this lesson is to have the students apply and synthesize what they've learned through the week.

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

1. *Identify trade-offs with different types of fisheries management.*

Standards Addressed: *Geography C 5: Environment and Society PO 4. Analyze the environmental effects of human use of technology (e.g., irrigation, deforestation, overgrazing, global warming, atmospheric and climate changes, energy production costs and benefits, water management) on the environment; PO 5. Analyze how humans impact the diversity and productivity of ecosystems (e.g., invading non-native plants and animals); PO 6. Analyze policies and programs for resource use and management (e.g., the trade-off between environmental quality and economic growth in the twentieth century); PO 7. Predict how a change in an environmental factor (e.g., extinction of species, volcanic eruptions) can affect an ecosystem.*

Themes: Systems thinking, trade-offs
Skills: Oral communication

Key Vocabulary

No new vocabulary

Teaching Instructions

1. Have students fill out the remaining reflection questions and graphs about the fishing game on the Part 2 handouts.
2. Students should be prepared to discuss the answers to their analysis questions with the class. Conduct a class discussion summing up the Tragedy of the Commons, the game play experience, and the trade-offs associated with common pool resources.
3. End class with a brief quiz based on the "Fishing for the Future" worksheet. Have students record their answers on the quiz forms.
4. Collect quiz forms and record scores in the excel document (automatically produces charts that summarize the class statistics on the quiz).
5. Briefly discuss answers to the post-assessment quiz with the students.
6. Class discussion about what students learned, would change, would keep the same.

Created by Brendan Denker