Lab 17

Nonrenewable Resource Depletion Activity

Author/School: Daniel Hyke; Alhambra High School; Alhambra, CA

Correlation

Miller 14th edition Chapters 17 and 16

Acorn Book–Topic Outline in the APES Course

IV. Land and Water Use

E. Mining

Purpose

This activity is designed to give students a hands-on understanding of how a nonrenewable resource is used up and eventually economically depleted.

Objectives

1. Learn that the extraction of a nonrenewable resource generally involves an increase in the amount of the resource extracted at first, culminating in a peak in resource extraction followed by an eventual decline in the amount of the resource obtained.
2. Discover the relationship between the difficulty of obtaining a resource and its cost.
3. Realize that the increasing cost of extracting a nonrenewable resource means that some of it will always be "left in the ground."

Background Information

Nonrenewable resources are, by definition, those resources that will not be replaced by natural processes once they are used up. Included in this category are all fossil fuels such as oil, natural gas, coal, tar sands, and shale oil, as well as minerals and gems like gold, silver, rubies, diamonds, and uranium. Many of these resources were produced inside the Earth through processes requiring millions of years. Most of the Earth's elements were created inside of stars long before the Earth itself was formed.

Several essential nonrenewable resources such as coal and oil have served as the foundation for the Industrial Revolution over the past two hundred years. Scarce elements such as gold and platinum have proven to be essential to the present Information Revolution and the complex, technological society of which we are all apart.

All of these non-renewable resources are limited. If we continue to use them, they will eventually run out or become too expensive to extract. How long it takes for society to run out of a particular nonrenewable resource depends on several factors: the demand for the resource, in other words, how fast we use it, the supply of the resource (some resources are far more plentiful than others), and technological innovation (new technologies, for example, may allow us to go deeper into the Earth after resources that were previously inaccessible).

The rate of use, or depletion, can be tracked for any particular nonrenewable resource. Government agencies and mining companies keep records of how much of a particular resource is extracted each year. By plotting the aggregate amount of a resource mined each year and graphing those amounts over a period or years or decades, resource depletion curves can be developed. A resource depletion curve will plot the extraction rate and eventual economic depletion of any particular nonrenewable resource.

Planners can use resource depletion curves to explore different scenarios of how long a resource will last by assuming various rates of extraction and use. Extrapolation into the future can help industry and society transition smoothly from the use of one resource to the next. A perfect example is that of oil. Economists and other government planners are now using oil depletion curves in an effort to determine how fast we will have to transition over to other fuels such as coal, natural gas, and hydrogen to power our vehicles as the oil runs out.

Materials For a Group of Four

One plastic container with pinto beans (overburden) and popcorn (gold nuggets)

Five plastic cups

A **Resource Depletion Data Collection Chart** for each student with follow up questions on the back, and a piece of graph paper or access to a computer if students would like to graph their data on a computer.

Procedure

Each student should obtain a plastic cup to put their "gold nuggets" in as they are mined. A fifth cup will be used by the group as a discard cup ("storage vault") into which everyone in the group will place their "nuggets" after they have been counted. Note: ***After they have been "mined", nuggets are never placed back into the plastic container with the pinto beans until the activity is completely over.***

To begin the activity, students should be placed in groups of four. Each group should be given one plastic container with a mixture of pinto beans and unpopped popcorn. Each group member should obtain a plastic cup and the group should get an extra discard cup to be used by everyone on the team.

Each student will represent a gold mining company. The popcorn kernels represent gold nuggets while the pinto beans represent the soil and overburden in which the "nuggets" are buried.

While mining, students can only use the index finger and thumb of ***one*** hand. No churning of the pinto beans with the other hand or removal of pinto beans is allowed. Students can remove more than one "nugget" at a time so long as they use only their thumb and index finger (no scooping allowed). If they grab pinto beans along with the popcorn nuggets, they must first put the pinto beans back before they can continue.

The activity begins with just one student who represents the first mining company to discover the gold. This one student will be the only one mining for the first four seasons. As the student collects nuggets, they will put them into their plastic cup. The first season will last for 5 seconds only. Using a watch or clock, the teacher will say "begin mining." After the time is up, the teacher will say "stop mining." The student then counts up the "nuggets" that they got and writes that number down in the column labeled "Total Nuggets Mined." The "Total Nuggets Mined" is then divided into the total cost of mining those nuggets for that particular year. For the first year, the total cost of mining the nuggets is $50 ($10 per second). For the following year it will be $100 (10 seconds x $10 per second). The cost of mining each nugget is then placed in the "Mining Cost Per Nugget" column. For example, if the student during the first season of mining (5 seconds) got four "nuggets," they would divide four into $50 (total mining cost for that season) and discover that it had cost them $12.50 to mine each "nugget." Note: After dividing, students should round off cost per nugget to the cents column. Mined "nuggets" are then placed into the storage vault (discard cup).

The activity continues as the first student completes three more seasons. At the start of the fifth season, the first student is joined by a second student from the group who represents the second mining company to join in the mining activity. For seasons five through eight, these two companies will mine simultaneously and then add up the total nuggets that they both obtain together and place that figure in the "Total nuggets mined" column. The total number of nuggets mined will be divided into the total cost of mining the nuggets for that particular season. All the mined nuggets are then placed into the "storage vault" (discard cup).

The activity continues with a third student joining in at the beginning of the ninth year and a fourth student joining in at the beginning of the thirteenth year. If a group has only three members, one student can play the roll of two companies by using two hands at the same time.

After the "mining" has been completed, it is time to graph and analyze the results. Students should label the sixteen mining seasons along the *x* axis with even spacing. The "Total Nuggets Mined" and the "Mining Cost Per Nugget" should be labeled along the *y* axes, one on the left side and one on the right side. Using different colors for each, students should graph the "Total Nuggets Mined" and then the "Mining Cost Per Nugget."

Data Analysis

1. During your activity, why was the extraction of "gold nuggets" slow and limited at first, but then increased as time went on?

2. In general, why is the exploitation of most resources slow and sporadic at first with demand increasing later on?

3. When oil was first discovered most people did not know what to do with it. In fact, in some cases it was considered a nuisance and something that you did not want contaminating your property. What were some of the reasons why oil became one of the most important resources on Earth?

4. During the activity, did the total number of "nuggets" extracted continue to rise all the way through to the sixteenth year? Explain.

5. During the activity did the mining cost per "nugget" continue to rise all the way through to the sixteenth year? Explain.

6. Consider the graph for the total number of nuggets. Is the increase as you approach peak production steeper or less steep than the decline after you pass peak production? Why?

7. Based on information from question six: Is maximum production most likely to occur towards the beginning of the resource depletion cycle or towards the end?

8. Why does the mining cost per "nugget" tend to rise over time?

9. When considering the mining cost per "nugget," how many times more cost effective was the forth year of mining compared to the sixteenth?

10. Were there any "gold nuggets" left in the plastic container at the conclusion of your activity? Why?

11. Do think the "cost" of getting those last few "nuggets" out of the container would be high? Why?

12. Please explain the phrases: "No resource is ever completely exploited" and "There will always be some oil left in ground."

13. How would the market price for "gold nuggets" affect production? At what year would you stop mining if the market price for "gold nuggets" was $25? At what year would you stop mining if the market price for "gold nuggets" was $100?

14. What kind of an effect does recycling have on the depletion curve of a nonrenewable resource? Are all nonrenewable resources recyclable?

15. How should society's approach towards the use of nonrenewable resources be different than its approach towards renewable resources?

16. How should we approach the use of those nonrenewable resources such as oil which cannot be recycled or reused?

17. What is the connection between the Tragedy of the Commons and the use of nonrenewable resources?

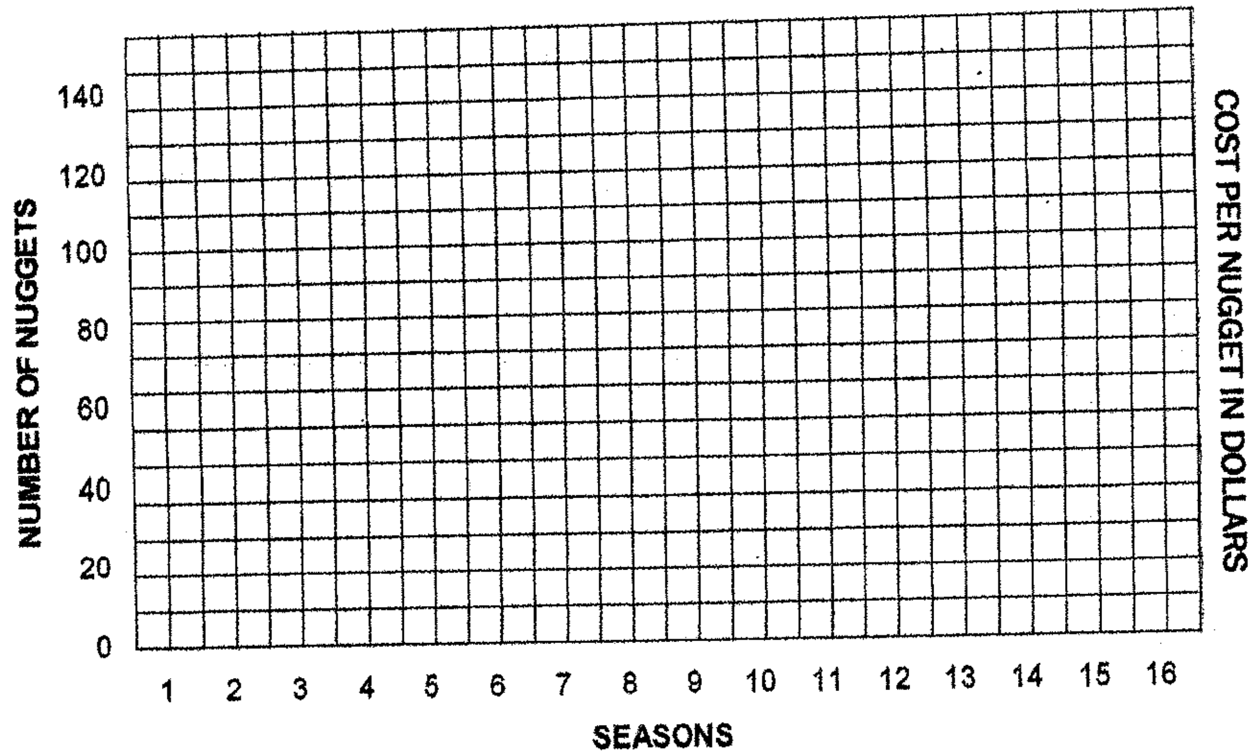
Important Terms

Depletion time
Economic depletion
Government subsidies
Nonrenewable resource
Peak production
Resource substitute
Royalties

Materials Sources

grocery stores (pinto beans)
natural food stores (pinto beans)
99 Cents Stores, Wal Mart, Target, etc. (plastic containers)

NONRENEWABLE RESOURCE DEPLETION GRAPH



Resource Depletion Data Collection Chart

Number of	Mining Time in Seconds	Total Mining Time for All Companies	Total Cost of Mining Nuggets	Year	Total Nuggets Mined	Mining Cost Per Nugget
ONE COMPANY MINING	5	5	$50	1		
	10	10	$100	2		
	15	15	$150	3		
	20	20	$200	4		
TWO COMPANIES MINING	25	50	$500	5		
	30	60	$600	6		
	35	70	$700	7		
	40	80	$800	8		
THREE COMPANIES MINING	45	135	$1350	9		
	50	150	$1500	10		
	55	165	$1650	11		
	60	180	$1800	12		
FOUR COMPANIES MINING	65	260	$2600	13		
	70	280	$2800	14		
	75	300	$3000	15		
	80	320	$3200	16		