**Mining and Land Reclamation – A Classroom Simulation**

*Indiana Expeditions Show:*
Earth Science

**Overview:**
Students will gain an understanding of the economics of mining, including costs associated with land reclamation following the mining process by “mining” chocolate chip cookies for their “ore” (i.e. chocolate chips).

**Background information:**
Minerals and other useful substances that are found within a body of rocks in sufficient quantities so as to make it profitable to mine them are called “ores”. In order to be useful, an ore has to be extracted or mined from the surrounding rock. Mining for an ore requires a significant initial monetary investment. This investment includes the cost of acquiring the use of the land where the ore is located, the machinery for removing the ore, and the labor involved in the mining process itself. The mining company gets a return on this initial investment by selling the ore that is mined.

The cost related to extracting ore is not the only cost associated with the mining process, however. Mining always impacts the environment in some way. Air, water, and land systems within the mining region can be impacted by the mining operation. For example, rock that is left over after the ore has been removed (i.e.: waste rock) has to go somewhere. Consequently, there are many laws that govern the mining process. These laws are designed to protect the environment during the mining process and to ensure that the environment is reclaimed or restored after the mining operation is no longer profitable. The process of restoring or reclaiming the land requires an additional financial investment.

Thus, there are many factors to consider when calculating the cost and profit associated with removing any particular ore form the ground.
Connections to the Indiana Academic Standards for Science:

3.1.3, 3.1.5, 3.1.6, 3.2.1, 3.2.6, 3.5.5, 3.6.3, 4.1.3, 4.2.4, 4.2.5, 4.3.6,
4.6.3, 5.1.3, 5.1.6, 6.1.2, 6.1.4, 6.1.5, 6.3.14, 7.1.7, 7.1.8, 7.1.10, 7.7.1

Science Process Skills:

- Calculating
- Classifying
- Communicating
- Hypothesizing and predicting
- Inferring
- Interpreting data
- Measuring
- Posing questions

Estimated Time Requirement

One 45-minute session

Materials:

- Flat toothpicks
- Round toothpicks
- Paperclips
- Paper towels – two per student
- Graph paper
- Mining and Reclamation Funsheet
- Three different types of chocolate chip cookies, each type with a different amount of chips.

Objectives:

Students will be able to

1. identify some of the costs and profits associated with mining for ore
2. appraise the cost-effectiveness of various mining options and relate them to real-world mining situations

Procedure:

Preparation prior to the lesson:

- Make one copy of the “Mining and Reclamation Funsheet” for each student.
- Determine which type of cookie has the most chips. This will be cookie “A”. The cookie with the fewest chips will be cookie “C” and the cookie with the middle number of chips will be cookie “B”.

Anticipatory set:

- View the Earth Science Indiana Expeditions segment
- If available, wear a hardhat and carry a shovel or pickax into class on the day of this activity to activate students’ curiosity!
Lesson sequence:

• Inform the students that today they are all going to mine for ore. Elicit from the students some of the things they will need in order to do this. For example, they will need some land to mine for the ore and tools to use in the mining process. Show them the various cookies, the toothpicks, and the paperclips and tell them they will be mining for chips from the cookies using the available tools.

• Let students know that like all businesses, they must operate within a budget and their goal is to make a profit. For this activity, they will have a starting budget of nineteen dollars. They will spend money for land acquisition, tools, labor costs, and land reclamation and will earn money for the ore they mine.

• Distribute the “Mining and Reclamation Funsheet”, one piece of graph paper, and two paper towels to each student.

• Explain the costs related to mining by letting the students know they can choose the type of land (cookie) they want to mine and the type of tool they want to use to do their mining. Students can choose from a range of high yield, yet more expensive, cookies or low yield, yet cheaper, cookies and between high quality, yet more expensive tools (paperclip), and lower quality (round and flat toothpicks), yet cheaper, tools. Tell students they may not do any mining by touching the cookie directly with their fingers! Thus, they will most likely need to purchase at least two tools.

• Ask students to decide what type of cookie they want to mine and what type(s) of tools they want to use. Tell students to record the cookie type, tool types, and associated costs in the appropriate place on their “Mining and Reclamation Funsheet”. Inform the students that they may not spend more than their initial budget on land, tools, and labor costs. Also, if a mining tool breaks, they must purchase a new tool.

• Let students know that they will earn two dollars for each whole chocolate chip they mine. Partial chip “ore” price will be determined by the purchasing company (aka: the teacher).

• Explain the reclamation process as follows:
  o When students get their cookie (their piece of land) they should place the cookie on their graph paper and trace around it.
  o All mining must take place on the graph paper.
  o At the end of the mining period, the land should be restored to its original condition within the circle that was drawn on the graph paper. Students will be allowed two minutes for the restoration process and may only use their tools during this process – no fingers! Also note that the height of the reclaimed land (cookie pieces and crumbs) cannot exceed the original height of the land (original height of the cookie).
- Any squares containing waste rock (cookie crumbs) outside of the original circle drawn on the graph paper will result in a reclamation expense as indicated on the “Mining and Reclamation Funsheet”.

- Once students have their materials, explain to the students that once they have their materials, you are the mine inspector. You will control the mining by allowing mining to occur in one minute increments.

- Distribute the appropriate cookies and tools to each student. Give students time to trace their cookie on the graph paper.

- Instruct the students to begin mining. Mined ore (chips) should be placed on a paper towel. At the end of one minute, instruct the students to put their tools down and record one minute under their labor costs on the “Mining and Reclamation Funsheet”. Students now need to decide if they want to continue mining. If so, repeat the previous procedure for a total of no more than five minutes of mining.

- Break work when student have decided they are finished mining, or when five minutes of mining have elapsed (whichever comes first). They should reclaim their land as indicated earlier and then calculate their total costs.

- Students, with teacher assistance as required, should then calculate their profit based on the number of whole chips mined. Note: Partial chip value can be assigned by the teacher.

- Instruct students to calculate their net profit or loss using the formulas provided on the “Mining and Reclamation Funsheet”.

- For cleanup, students may eat their “mine” and “ore”.

**Closure:**

- Discuss, as a class, the costs and profits associated with their mining experience and then ask the students how this relates to real-world mining situations.

**Suggested Student Assessment:**

**Objectives #1 and #2:**

Ask students to write and/or illustrate what they did during this activity and what they learned from their participation in the activity.

**Extending the Lesson:**

- Ask students to supply some scenarios that might effect mining operations in either a positive or negative way. Record the student ideas on index cards. Determine a cost or profit associated with each scenario and write that dollar amount on the corresponding card. Repeat the mining activity but after one minute of mining randomly chosen students must draw a scenario from the deck of cards and add in that cost or profit to their financial statement for their mining operation.
• Encourage students to do some research about mining. For example, they could find out what types of mines found in their home state, or they could try to find the most valuable thing in their own home that contains materials that came from a mine.

Source of Lesson:
Deb Sachs,
Director, Office of Professional Development
School of Education
University of Indianapolis

Adapted from “Cookie Mining”
http://www.womeninmining.org/cookie1.htm
Accessed December 19, 2007
## Costs/Expenses

<table>
<thead>
<tr>
<th></th>
<th>My expenses:</th>
<th>My expenses:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Land acquisition:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cookie “A” $7</td>
<td>$_____</td>
<td></td>
</tr>
<tr>
<td>Cookie “B” $5</td>
<td>$_____</td>
<td>$_____</td>
</tr>
<tr>
<td>Cookie “C” $3</td>
<td>$_____</td>
<td>Flat toothpicks ___ x $2 $_____</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Round toothpicks ___ x $4 $_____</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Paperclips ___ x $6 $_____</td>
</tr>
<tr>
<td><strong>Labor costs:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of minutes</td>
<td>_____ x $1</td>
<td>$_____</td>
</tr>
<tr>
<td></td>
<td>$_____</td>
<td>$_____</td>
</tr>
</tbody>
</table>

### Total for this column $______

### Total for this column $______

### Total costs (total of both columns) $______

## Profits

- Number of whole chips mined ___ x $2: $______
- Value of partial chips mined (as determined by the teacher): $______

### Gross profit $______

## Net Profit or Loss

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Start up funds</td>
<td>$19</td>
</tr>
<tr>
<td>Less total costs</td>
<td>- ________</td>
</tr>
<tr>
<td>Plus gross profit</td>
<td>+ ________</td>
</tr>
</tbody>
</table>

### Total net profit or loss $______