MINING AND ACCOMPANYING CAREERS

Grade Level: 9-10
Course: Applied Science / Earth Science

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This Unit Plan is my original work completed specifically for ENG 5101. All work that has been adapted/adopted for use in this Unit Plan has been properly cited.

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Signature     Date
**Unit Overview:** The basic premise behind this unit plan is to use mining to teach science content while showcasing a variety of “real world” careers in math and science. The unit includes the mining process from exploration of ore bodies and automated removal of that ore to the economics surrounding mining decisions.

**Desired leaning out comes**

- Students will use remote sensing to explore subterranean soil profiles.
- Students will use programming and building skills to make a Lego RCX robot perform mining in a mineshaft.
- Students will use statistic to figure out the economic viability of mining an ore body.

**Prior knowledge necessary**

- Rock cycle, mineral identification, mineral formation, and graphing skills.
- Basic Lego RCX programming and building experience. Typical mine layouts and practices.
- Algebra math level.

**Book/sources Consulted:**

- “3D modeling”, Class notes for the Teacher’s Earth Science Institute, Michigan Technological University at Houghton, Summer 2005.

- “Surface mine cost comparison” Class notes for the Teacher’s Earth Science Institute, Michigan Technological University at Houghton, Summer 2006.


- M. Spreitzer (private conversation), 2006.

Michigan Content Expectations:

E1.p1 Identify common minerals by their properties. (*middle school prerequisite*)

E1.1A Identify common igneous, metamorphic and sedimentary rocks and describe the processes that change one kind of rock to another.

E1.1B Explain the relationship between the rock cycle and the plate tectonics theory.

E1.4C Explain, using specific examples, how a change in one system affects other Earth systems.

E1.4D Describe how the interaction of physical processes and human activities impact water, land and air.

E2.1A Explain how scientists infer that the Earth has interior layers.

E2.1B Explain the uncertainties associated with models of the interior of the Earth and how these models are validated.

E2.R2 Develop a scale model based on data that describes the nature of the Earth’s interior.

E3.4A Describe how glaciers have affected the Michigan landscape and how the resulting landforms impact our state economy.

E5.3B Explain how human activities impact air, soil and water quality.

E5.3C Explain how one human activity, for example, cutting down a large tract of forest for mining, can affect the entire Earth system.

S4.2.2 Apply probability concepts to practical situations, in such settings as finance, health, ecology, or epidemiology, to make informed decisions.

S1.3.2 Describe characteristics of the normal distribution, including its shape and the relationships among its mean, median, and mode.
Lesson 1 (How do drillers know where to drill):

Geologists use core drilling to gain an understanding for what is beneath the earth’s surface. The rock core drills use diamond bits to cut small holes to enable geologists to see rock layer patterns. Rock samples are drilled and drawn from the ground in three-foot sections. Geologists then identify the rocks and the thickness of each layer is recorded for future use.

Objective:

Students will use remote sensing to record data from an earth model.

Time required:

45-50 minutes

Materials:

Earth model with drill cores, rulers, drill core data sheets, and PowerPoint

Real World Application:

Measuring, data collection and exposure to drilling practices.

Prior Knowledge Review:

Measuring and mineral identification.

Lesson Modeling and Practice:

Questioning session: Students are shown a plain brown box and asked how they would determine what is inside the box, without opening it. The students are then shown a 3-D model of a land area and asked how they could figure out what the rock layers look like below the topography. Hopefully the students will see that the best way to learn what is present below the surface is to drill into the ground and record the type of material that the drill brings to the surface.

The land model will be divided into 10 slices with each slice, or plate containing 10 “drill cores.” Drill cores are unevenly distributed along the plate line. These cores will be color coded to indicate where each different rock type resides in the plate.

At this point the teacher gives a short lecture on mining exploration and the careers involved with the mining.

Show the class drill core examples. Demonstrate to the students how to record drill core information. Explain what rock type each different layer on the drill core represents.
Divide the class into smaller groups (2-4 students) and assign each group a plate area of the model. One member from each “drilling team” will come to the model and remove the 10 cores from their plate.

Have the students measure and interpret the drill core information for their plate and record it in their corresponding data table.

**Reinforcement and Assessment:**

Check to see data tables are filled in.
Lesson 2 (The job of the geologist):

Objective:

Students will act as geologists to understand how rock layer orientation and mineral deposit formation.

Time required:

45-50 minutes

Materials:

8 ½ x 11 Graph paper (1cm boxes), protractors, colored pencils, rock samples to display and PowerPoint.

Real World Application:

Graphing Skills, Rock and mineral familiarly.

Prior Knowledge Review:

Graphing skills and mineral identification.

Lesson Modeling and Practice:

Students will get a short lecture on rock layers and ore bodies then draw their cross-sections from drill core data. The drill core information will be graphed on letter sized (8 ½ x 11) graph paper and rock layers are color-coded to rock samples that are displayed to the class. One drill hole should be done as an example.

Reinforcement and Assessment:

Check to see graphs are made and colored.
Lesson 3 (Graphic Designing)

Objective:

Students will act as graphic designers to create a three dimensional model of the rock layers and ore body found in side our model earth.

Time required:

45-50 minutes

Materials:

8 ½ x 11 plastic sheets, “plastic sheet hanger”, PowerPoint and dry erase markers.

Real World Application:

3-D Visualization

Prior Knowledge Review:

None Required

Lesson Modeling and Practice:

The “graphic artists” then transfer the graphs from paper to plastic sheets (overheads on file drawer hangers work great…see picture below). The plastic sheet are colored with dry erase markers corresponding to the graph paper, showing different rock units. The surface and reference lines will be provided on the plexiglass sheet. The series of these cross-sections shows the orientation of the rock layers in three dimensions.
Reinforcement and Assessment:

After completion of the 3-D model, the teacher will reveal the interior of the earth model to the class. After examining the original earth model, students will compare the original to the model that their class created. Each student will be asked to write an essay describing what they think happened to contribute to any discrepancies between the two models, and also what they see helped them to create a model that accurately represented the original. What was their favorite part about the assignment? What was their least favorite part? What aspect of the assignment would they most likely use in their other subjects/life outside of school?
Lesson 4 (Automated Mining):

Objective:

Students will design and build a load-haul vehicle (LHV) with a Lego RCX kit that can automate a mining operation.

Time required:

Three class periods of 45-50 minutes each.

Materials:

Lego RCX building kits, Computer, “mine making materials”…long cardboard box, tape, and white paper.

Real World Application:

Problem solving, building, and programming skills.

Prior Knowledge Review:

Basic programming the Lego RCX units and mine layouts.

Lesson Modeling and Practice:

Perform the challenge (see the attached sheet).

Reinforcement and Assessment:

Grade on robot performance:
A+ VHV performs hauling task three times with lights and back up alarm.
A VHV performs hauling task three times.
B VHV performs hauling task three times with minimal assistance.
C VHV enters the mine and returns.
D VHV enters the mine.
F Student does not build VHV
Challenge
Design and build a load-haul vehicle (LHV) that can drive into a mine addit until it reaches loose blast rock. The LHV should fill its front bucket with muck rock, raise the bucket, and drive back out of the mine. Upon exiting the mine, the LHV will stop and dump its load. The LHV will then reenter the mine and repeat this process.

Procedures

Experimental Setup: A length of black paper representing the mine addit will be placed on the classroom floor. White paper will be used at one end to represent the mine entrance and marbles will be place along the other end to represent muck rock to be removed.

Robot Design: Modify your RCX car to drive using only one motor and include an operating bucket that can scoop, lift, and dump muck rock (using the other motor). Optional - have head light come on when LHV enters the mine - have alarm sound when LHV is backing up

Grading:

A+ VHV performs hauling task three times with lights and back up alarm.
A  VHV performs hauling task three times.
B  VHV performs hauling task three times with minimal assistance.
C  VHV enters the mine and returns.
D  VHV enters the mine.
F  Student does not build VHV.
Lesson 5 (The Value of Statistics):

Objective:

Students will use the basic statistical vocabulary (mean, median, and mode) to figure out if an ore body is worth mining.

Time required:

Two class periods of 45-50 minutes

Materials:

Guest Speaker (Marketing teacher), “Should we mine?” worksheet, mining ore cost guide

Real World Application:

Basic ideas in business, working with money

Prior Knowledge Review:

Mean, median, and mode definitions

Lesson Modeling and Practice:

The teacher should begin the day with a class discussion on what would make a mine profitable to open. Both the profits and the expenses should be discussed. A guest speaker on the topic of supply and demand will enrich discussion on the business of mining. After a good discussion an example problem on the worksheet should be done together. Students will then complete the worksheet independently.

Reinforcement and Assessment:

Checking of the “should we mine” worksheet and short verbal quiz on mean, median, and mode. The quiz should include but definitions and number questions.
SHOULD WE MINE?

The mean, median, and mode are single numbers that help describe how the individual scores in a data set are distributed in value. A data set consists of the observations for some variable is referred to as raw data or ungrouped data.

**The Mean**… another name for the average of a set of scores. The mean can be found by dividing the sum of the scores by the number of scores.

**The Median**… The median of a set of data values is the *middle* value once the data set has been arranged in order of its values.
- If you have an even number of values such as 1, 2, 5, and 8, the median is the average of the two middle numbers.

**The Mode**… The mode of a set of data values is the number in the set that appears most frequently.
- If no number appears more than once, then the data set has no mode.
- You can have two modes if two numbers “tie” for being the most frequent.

Give the Mean, Median, and Mode for each data set.

<table>
<thead>
<tr>
<th>Data Set</th>
<th>Mean</th>
<th>Median</th>
<th>Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. 18, 18, 19, 19, 20, 20, 21, 22, 23, 23</td>
<td>Mean=</td>
<td>Median=</td>
<td>Mode=</td>
</tr>
<tr>
<td>2. 23, 49, 65, 89, 30, 89, 29, 85, 87, 45, 33</td>
<td>Mean=</td>
<td>Median=</td>
<td>Mode=</td>
</tr>
<tr>
<td>3. 21, 19, 70, 39, 40, 81, 59, 85, 12, 23, 24</td>
<td>Mean=</td>
<td>Median=</td>
<td>Mode=</td>
</tr>
<tr>
<td>4. 3, 9, 62, 0, 45, 3, 25, 25, 86, 95, 32, 78</td>
<td>Mean=</td>
<td>Median=</td>
<td>Mode=</td>
</tr>
</tbody>
</table>
There are three different haulage truck drivers and each has carried five loads. You have each of the driver’s loads.

<table>
<thead>
<tr>
<th>Load 1</th>
<th>Load 2</th>
<th>Load 3</th>
<th>Load 4</th>
<th>Load 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Driver 1</td>
<td>123</td>
<td>124</td>
<td>124</td>
<td>125</td>
</tr>
<tr>
<td>Driver 2</td>
<td>125</td>
<td>123</td>
<td>125</td>
<td>126</td>
</tr>
<tr>
<td>Driver 3</td>
<td>129</td>
<td>125</td>
<td>128</td>
<td>128</td>
</tr>
</tbody>
</table>

1. Suppose you were the owner of the mine. You want to know what drive to give employ of the month to. If you rank drivers by their mean loads, which driver would be employ of the month?

2. Instead of using the mean, you use the median of each driver to make your decision. Which driver would be the employ of the month?

3. Pretend presenting to a group of potential investors. Would it be better for you to report the mean loads or median loads (remember investors want to see more ore)?

4. Using the mean load for all your drivers (the mean for all the data), if each drive made could make three trips per day how much ore could they bring out of the mine? Also calculate five, ten, and fifteen trips.

***For questions 5 & 6 use the surface mine cost comparison chart.***

5. If your drives brought out 5,000 tons of 1% copper ore with 2:1 waste rock ratio per day, what would it cost you and how many tons of copper would you have after refining?

6. How much would you profit from those 5,000 tons of ore if the copper market value were $1.23? $2.54? or $3.78?

7. Explain three reasons why mine owners have a lot to take into consideration when deciding whether to mine or not. (please do these on a separate sheet of paper)