PROJECT REPORT

Northern Wyoming Community College District / National Science Foundation
Summer Energy Education Program 2011

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TITLE

STEM UNIT on ENERGY AND MINING

SUMMARY

This STEM Unit will encompass about 10 teaching periods and will cover various contents:

A. MATHEMATICS
1. Scientific Notation
2. Area, Volume and Conversions
3. FDP (Fractions, Decimals and Percentages)
4. Exponential Functions and Regression Analysis (for advanced students)

B. SCIENCE
1. "Science of Energy" (from www.energyforeducators.org)
2. Chemical reactions and half-life
3. Carbon Footprint Calculator (www.nature.org)

C. TECHNOLOGY
1. PowerPoint Presentation
2. Identifying Technology/Machinery

D. ENGINEERING
1. Auto-CAD
2. Laboratory Investigation
3. Field Trip (Jamesville Quarry)

ENERGY CONTEXT

As the world's population continues to rise, the demand for energy multiplies. However, limited fossil fuel supplies over the years has shown considerable and rapid decline in production leading energy companies to look at other alternative sources. The focus of policy makers and big energy companies has shifted to environmental sustainability, competitiveness and security of energy supply. Laws and regulations are implemented to ensure responsible extraction and governments around the world are stepping in to properly implement these strict standards and safety measures.

ANTICIPATED TIME REQUIRED

10 teaching periods (45 minutes period) and a whole day Field Trip

INTENDED STUDENT LEVEL

This project will present learning and assessment activities intended for high school students, specifically 9th and 10th grades but can also be replicated for Grades 6-8.

Supplementary activities are also planned to target higher level students in Pre-Calculus, AP Statistics, AP Calculus (11th – 12th graders)

ASSUMED PRIOR KNOWLEDGE

Students must have:

- Basic computational skills
- Experience with graphing calculators
- Basic Word Processing software skills
- PowerPoint experience is a plus!

LEARNING OBJECTIVES

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

- **Learn about energy sources and its production and consumption**
- **Compare and contrast: renewable versus non-renewable energy sources**
- **Understand radioactive decay by using mathematical and statistical methods of presenting and comparing data**
- **Estimate their family's annual carbon dioxide usage and its impact to the climate**
- **Review algebraic concepts: scientific notation, fraction-decimal-percent, area and volume, half-life and exponential equations**
- **Construct and interpret graphs, read and analyze tables, and use these graphical displays to represent and justify mathematical situations**
- **Acquire a first-hand (hands-on) experience an open-pit mine operation by visiting a diamond quarry**
- **Examine the effect of mineral extraction, weathering and erosion on the filling materials and surrounding landscape of an open-pit mine by conducting a simulation in the laboratory**
- **Integrate technology in their final presentation (output) using PowerPoint and/or AutoCAD**
- **Produce a proposal of an open-pit mining Reclamation Plan**
- **Justify the feasibility of the Reclamation Plan and the accuracy of the solution to the Main Problem by completing a Self-Assessment Worksheet**
- **Evaluate their classmates' presentations using the Peer Evaluation Rubric**
- **(AP Statistics Students) Design a Regression Analysis Matrix of the sustainability of the Energy Resource Production and Consumption in the US**

MATERIALS

Instructional Materials:

- **Board and chalk or marker**
- **Pre-printed worksheets and rubrics (see attachments)**

Technology:

- **SmartBoard or other Interactive whiteboards**
- **Classroom set of laptops/PCs with Microsoft PowerPoint**
- **Computer with AutoCAD installed**

Laboratory:

- **Rocks, stones and sand**
- **Plastic cups**
- **Water**
- **Pins/Needles**
- **Poly gloves**
- **Safety Googles**

Field Trip:

- **Permission Slips**
- **Waiver/Release Forms**

INTRODUCTION/MOTIVATION FOR STUDENTS

A film clip of mining machineries will be shown to the students.

(How Stuff Works/Discovery Channel: How Do They Do It: Coal Mining, 6 minutes)

http://science.discovery.com/videos/how-do-they-do-it-coal-mining.html

Students will be encouraged to take down notes.

Emphasis: technology/machineries

PROCEDURE

This STEM unit on Mining and Energy is divided into 8 periods classroom encounter (45-minute period) including 1 period laboratory and 1 period laboratory analysis, 2 class periods for presentation and 1 whole day field trip.

Day 1:

Introduction to the STEM Energy Unit

Agenda:

1. **Brief Overview and Outline Presentation**
2. **Introduction of Faculty/Staff Involved**
3. **Distribution of Hand-outs, Permission Slips, Agenda, Guidelines and/or Student Contract, etc.**
4. **Video Clip: How Stuff Works/Discovery Channel: How Do They Do It: Coal Mining**

   http://science.discovery.com/videos/how-do-they-do-it-coal-mining.html

Evaluation:

Students will complete a worksheet (about mining machineries)

(Attachment 2)

Homework/Extension:

Create a list of mining operations in the Tri-State area (New York, New Jersey and Connecticut) and its production per year (in tons).

Day 2:

ENERGY Connection:

1. **This lesson needs planning/collaboration with a science teacher.**
2. **The plan:**
   - **Motivation: Carbon Footprints Calculator**

     http://www.nature.org/greenliving/carboncalculator/index.htm
   - **Mini-lesson on Renewable versus Non-renewable Energy Sources (Attachment 12)**

     http://www1.eere.energy.gov/education/pdfs/basics_energyanalysis.pdf

Day 3:

MATHEMATICS CONNECTION: Scientific Notation

Aim: How do we write decimals in scientific notation?

Learning Objective: Students will be able to:

1. **Explore multiple representations of very large and very small numbers**
2. **Write decimals in scientific notation**
3. **Apply the concept of scientific notation to solve real-world problems**

Standards:

New York State

A.N.4 Understand and use scientific notation to compute products and quotients of numbers greater than 100%

A.PS.5 Choose an effective approach to solve a problem from a variety of strategies

A.RP.2 Use mathematical strategies to reach a conclusion and provide supportive arguments for a conjecture

A.CM.2 Use mathematical representations to communicate with appropriate accuracy, including numerical tables, formulas, functions, equations, charts, graphs, Venn diagrams, and other diagrams

A.CN.6 Recognize and apply mathematics to situations in the outside world

A.R.6 Use mathematics to show and understand physical phenomena

Do-Now:

Complete the worksheet.

(Attachment 6)

Mini-Lesson:

Teacher will demonstrate the strategy of using scientific notation to express very large numbers and very small numbers. The Do-Now activity (Attachment 1) will be utilized as a whole group reference since the students has the worksheet in hand.

Teacher will ask volunteers to convert the coal production numbers into scientific notation.

TECHNOLOGY INTEGRATION: SmartBoard™ (or other interactive whiteboards) will be used to show the chart and for student volunteers to fill in.

Student Activity:

1. **Divide students into pairs.**
2. **Each pair will get a laptop.**
3. **Allow students to browse preset attachments on their computers (Attachment 3) or Wyoming Oil Production by County 2010 and ask them to examine one column. They**

should be able to convert the contents of the column into scientific notations.

4. **After looking at the 2010 Oil production in the state of Wyoming, let the students compare the production in 1978 (Attachment 4) Wyoming OilProduction by County 1978 and the production in 1995 (Attachment 5) Wyoming Oil Production by County 1995. (Source: http://wogcc.state.wy.us/CountyReport.CFM)**
5. **Let the students make a conclusion of how the production of oil in the state of Wyoming changed in the set time span (1978 – 1995 – 2010).**
6. **[Troubleshooting/Differentiation: If the students struggle with limited data, show them the site http://wogcc.state.wy.us/CountyReport.CFM and let them download the information for the other years]**

Evaluation:

Students will be able to compare and contrast the data/information they are looking at and they should be able to write an evidenced based conclusion of the changes in the production of oil in the state of Wyoming.

Homework/Extension:

See attachment (Attachment 6)

Day 4:

MATHEMATICS/SCIENCE CONNECTION: Volume and Conversion

Aim: How do we find the volume of an irregular solid?

Learning Objective: Students will be able to:

1. **Identify and differentiate regular solids with various polygons as their bases**
2. **Verbalize the formula for finding the volume of regular solids**
3. **Create a system of finding volumes of solid by filling or taking away portions of the original polyhedron**
4. **Use the basic concept of volume to solve real-world problems**

Standards:

New York State

G.CM.1 Communicate verbally and in writing a correct, complete, coherent, and clear design (outline) and explanation for the steps used in solving a problem

G.PS.1 Use a variety of problem solving strategies to understand new mathematical content

G.CN.6 Recognize and apply mathematics to situations in the outside world

G.G.11 Know and apply that two prisms have equal volumes if their bases have equal areas and their altitudes are equal

G.G.12 Know and apply that the volume of a prism is the product of the area of the base and the altitude

G.G.13 Apply the properties of a regular pyramid, including:

- **lateral edges are congruent**
- **lateral faces are congruent isosceles triangles**
- **volume of a pyramid equals one-third the product of the area of the base and the altitude**

G.G.14 Apply the properties of a cylinder, including:

- **bases are congruent**
- **volume equals the product of the area of the base and the altitude**
- **lateral area of a right circular cylinder equals the**
- **product of an altitude and the circumference of the base**

G.G.15 Apply the properties of a right circular cone, including:

- **lateral area equals one-half the product of the slant height and the circumference of its base**
- **volume is one-third the product of the area of its base and its altitude**

Do-Now:

Students will complete a worksheet "Identifying Solid Figures" (courtesy: KutaSoftware)

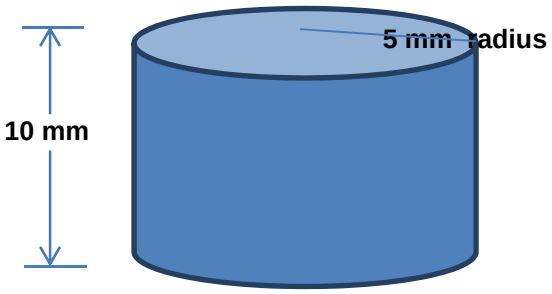
[Attachment 7]

http://www.kutasoftware.com/FreeWorksheets/GeoWorksheets/10-Identifying%20Solid%20Figures.pdf

Mini-Lesson:

- **Teacher-led discussion on types of solids**
- **Teacher would then solicit previous knowledge on the formula of regular solids**
- **Students will make a list of formulas**
- **Challenge:**

In order for a machinist to fit a special washer on a bolt, he has to cut a circular hole with radius 2 mm all the way down to the base of a cylindrical tube.
If the original cylinder has 5 mm radius and 10 mm height.



Solid Tube

Find the volume of the washer after drilling the hole.

TECHNOLOGY INTEGRATION: SmartBoard™ (or other interactive whiteboards) will be used.

Student Activity:

1. **Students will be grouped in pairs.**
2. **Each pair will get a copy of the "Plan View Big Horn No. 9-1 Reservoir" blueprint**
3. **Students will then compute the volume of extracted materials as shown in the plan.**
4. **Each pair will then present the whole class their work.**

Evaluation:

Each group/pair will be evaluated using the Performance Task General Rubric for Mathematics

[Attachment 8]

(http://www.sites4teachers.com/links/redirect.php?url=http://www.rubrics4teachers.com/pdf/PerformanceTaskRubric.pdf)

Day 5:

Proposed FIELD TRIP TO AN OPEN PIT MINE: Jamesville Quarry

- **Logistics need to be carefully planned – permission slips must be properly distributed and collected, chaperones and supervisory involvement must be implemented, etc.**
- **Points of consideration: There is a 100-mile radius/one-school-day policy for Educational Trips in NYC.**
- **The main objective of this trip is for the students to see and observe an open pit mine, not really on energy. However, a list of guide questions can be generated which will lead students back to the energy content.**

  Example: How much fuel machines consume in a day? Is the end-product (of obtaining a commercial-grade diamond) worth the expenses for fuel consumption? At the current rate of the energy consumption, how many more years can this mine site sustain the operations?

Day 6 - 7:

MATHEMATICS/SCIENCE COLLABORATION: Volume and Density Laboratory

Since this is a collaborative lesson, there should be a prior planning and brainstorming with the science teacher. You should update this part as soon as the said meeting takes place.

The plan:

1. **Allow the students to experiment with sand, soil, stones or small rocks:**
2. **They will measure the volume of the cylindrical container full of the materials mentioned above.**
3. **The students would then take 3 small rocks from the container, measure and find its total volume.**
4. **They would then compare their results: analytically (using the volume formula) and by physically measuring the remaining materials in their containers.**
5. **Pour in some amount of water and check whether the volume remains constant.**
6. **Compute the density before and after water was added.**
7. **The students will then make a deduction based upon the result of the lab.**

Aim:

Learning Objective: Students will be able to:

1.
2.

Standards:

New YorkState

Do-Now:

Mini-Lesson:

TECHNOLOGY INTEGRATION: SmartBoard™ (or other interactive whiteboards) will be used.

Student Activity:

Evaluation:

Homework/Extension:

Day 8:

Presentation of the MAIN PROBLEM

Agenda:

1. **Background Information: Video Clip**

   Mountaintop Mining: The Good, the Bad and the Ugly (6:14)

   (http://www.youtube.com/watch?v=As2W3X_bClo&feature=related)

2. **The MAIN PROBLEM: PowerPoint presentation (See Attachment 10)**

   U.S. Government Official Office of Surface Mining Reclamation and Enforcement

   http://www.osmre.gov/

3. **Students will be given a topographic map, dimensions of the pit and other information they need for their Reclamation Project.**

Day 9:

1. **AutoCAD tutorial**
2. **Students will start planning and implementing their projects**

Day 10:

1. **General PowerPoint tutorial**
2. **Students work on their project.**

Presentation Day/s:

Final presentation:
Each pair will be given a maximum of 10 minutes for their presentation.
Evaluation is based on two rubrics:

SAFETY ISSUES

1. **For the laboratory work using rocks, soil and water, students must wear at least a poly glove and safety goggles.**
2. **For the field trip, all waivers and permission slips must be signed and submitted prior to the trip schedule. 1 adult to every 10 students must be strictly followed.**

TROUBLESHOOTING TIPS

Problems and troubleshooting will be addressed as it comes out but all safety and precautionary measures must be dealt with before hand.

ASSESSMENT

Daily assessments will take place after each class period: Do-now activities, share-out, quizzes and homework assignments. (Refer to Attachments)

The students' final project presentation of their Reclamation Plan – their answer to the Main Problem. Students will be evaluated based on 2 rubrics:

Oral Presentation (See Attachment 9)

PowerPoint Rubric (See Attachment 10)

SUGGESTED EXTENSIONS

For advance students:

- **Regression analysis of the oil and gas production of the state of Wyoming which will lead students to predict the trend and sustainability of the wells.**
- **Estimating the age of mountains by computing the depth of the valley/gorge created by a river or stream (using trigonometry to compute the depth – angle of elevation/inclination)**
- **After learning about energy and carbon footprints, writing an Environmental Impact Statement should be an excellent extension**

General Suggestions:

- **Create an Energy Watchers Club or Energy Conservation Society in the building is a good idea**
- **More inter-disciplinary collaboration needed between Science, Mathematics, Engineering and Technology teachers**