Mountaintop Removal Coal Mining

By Kate Catlin

INTRODUCTION:

This lesson will inform students about coal mining and its connection to energy use, while empowering them to reduce energy in their own lives.

LESSON OVERVIEW:

Grade Level & Subject: K-12: Science, Social Studies, and Mathematics

Length: 90 minutes (with a preliminary homework assignment and potential follow-up activities)

Objectives:

- Students will learn how detrimental mining for coal is to the environment
- Students will learn ways to reduce energy usage.

National Standards Addressed:
This lesson addresses the following National Education Standards.[1]

- Content Standard: NS.9-12.1 SCIENCE AS INQUIRY
  As a result of activities in grades 9-12, all students should develop
  - Abilities necessary to do scientific inquiry
  - Understandings about scientific inquiry
- Content Standard: NS.9-12.3 LIFE SCIENCE
  As a result of activities in grades 9-12, all students should develop an understanding of
  - The cell
  - Molecular basis of heredity
  - Biological evolution
  - Interdependence of organisms
  - Matter, energy, and organization in living systems
  - Behavior of organisms
- Content Standard: NS.9-12.4 EARTH AND SPACE SCIENCE
  As a result of activities in grades 9-12, all students should develop an understanding of
  - Energy in the earth system
  - Geochemical cycles
  - Origin and evolution of the earth system

[1] http://www.education-world.com/standards/

    - Origin and evolution of the universe
- Content Standard: NS.9-12.5 SCIENCE AND TECHNOLOGY
  As a result of activities in grades 9-12, all students should develop
    - Abilities of technological design
    - Understandings about science and technology
- Content Standard: NS.9-12.6 PERSONAL AND SOCIAL PERSPECTIVES
  As a result of activities in grades 9-12, all students should develop an understanding of
    - Personal and community health
    - Population growth
    - Natural Resources
    - Environmental quality
    - Natural and human-induced hazards
    - Science and technology in local, national, and global challenges
- Content Standard: NSS-G.K-12.2 PLACES AND REGIONS
  As a result of activities in grades K-12, all students should
    - Understand the physical and human characteristics of places
    - Understand that people create regions to interpret Earth's complexity
    - Understand how culture and experience influence people's perceptions of places and regions
- Content Standard: NSS-G.K-12.3 PHYSICAL SYSTEMS
  As a result of activities in grades K-12, all students should
    - Understand the physical processes the shape the patterns of Earth's surface
    - Understand the characteristics and spatial distribution of ecosystems on Earth's surface
- Content Standard: NSS-G.K-12.5 ENVIRONMENT' AND SOCIETY
  As a result of activities in grades K-12, all students should
    - Understand how human actions modify the physical environment
    - Understand how physical systems affect human systems
    - Understand the changes that occur in the meaning, use, distribution, and importance of resources
- Content Standard: NSS-C.9-12.5 ROLES OF THE CITIZEN
  What are the Roles of the Citizen in American Democracy?
    - What is citizenship?
    - What are the rights of citizens?
    - What are the responsibilities of citizens?
    - What civic dispositions or traits of private and public character are important to the preservation and improvement of American constitutional democracy?
    - How can citizens take part in civic life?
- Content Standard: NM-PROB.REA.PK-12.2
  Make and investigate mathematical conjectures
- Content Standard: NM-DATA.9-12.3
  Develop and evaluate inferences and predictions that are based on data
    - Use simulations to explore the variability of sample statistics from a known population and to construct sampling distributions

- Understand how sample statistics reflect the values of population parameters and use sampling distributions as the basis for informal inference
- Evaluate published reports that are based on data by examining the design of the study, the appropriateness of the data analysis, and the validity of conclusions
- Understand how basic statistical techniques are used to monitor process characteristics in the workplace

Materials Needed:

- Computers with internet access
- 10 bandanas (4 black, 2 blue, 2 red, 2 green)
- Calculators
- (optional) poster board and markers
- Reproducible #1 - **At Home: Monitoring Your Energy Use!** Pre-Assignment
- Reproducible #2 - **Kayford Mountain Photo** (copy for class or enlarge for display)

Assessment: Students will be assessed on the preparatory homework assignment, classroom activities and calculations, contribution to discussions, and overall participation.

LESSON BACKGROUND

Information: *Coal as a power source*

The adverse effects of coal are vast and widespread. Because it can be acquired domestically in a relatively cheap manner, coal remains our largest source of energy, accounting for just under half of our energy usage.[2] The United States mined **1,145.6 million short tons** in 2007![3] All this coal contributes to around 36% of CO_2 emissions in the United States, which is the main contributor to global climate change. Coal-fired power plants are also second only to automobiles as the greatest source of emissions for smog and ozone, and are the highest source of acid-rain-causing SO_2.[4] Lastly, they release massive amounts of particle pollution and soot, which means our air is dirtier and less healthy. The tragedy is that the average coal-fired power plant is only 1/3 efficient; meaning 2/3 of the energy in the fuel is wasted.[5]

Even before the coal is used for power, just taking it out of the ground causes environmental problems. Surface mining of coal completely eliminates existing vegetation, destroys the genetic soil profile, displaces or destroys wildlife and habitat, degrades air quality, alters current land uses, and to some extent permanently changes the general topography of the area mined. Mine tailing dumps produce acid mine drainage which can seep into waterways and aquifers, with **consequences on ecological and human health**. If underground mine tunnels collapse, this can cause subsidence (downward shifting or caving) of land surfaces. During actual mining operations, a potent

[2] http://www.eia.doe.gov/cneaf/electricity/epa/figes1.html
[3] http://www.eia.doe.gov/cneaf/coal/page/special/feature.html
[4] http://www.sierraclub.org/cleanair/factsheets/power.asp
[5] http://leahy.senate.gov/issues/environment/ca_stats.html

greenhouse gas, methane, may be released into the air. And by the movement, storage, and redistribution of soil, the community of microorganisms and nutrient cycling processes can be disrupted.[6]

While coal-generated energy does significant amounts of damage, it is possible for every citizen to minimize its effects. If everyone uses **less energy**, we can decrease the amount of coal that we must produce. It's also important to push for new, clean, renewable sources of energy like **wind and solar power**.

LESSON STEPS

Warm-up: *Monitoring Your Energy* *Pre-Assignment* – For the Night Before
Send students home with Reproducible #1 - **At Home: Monitoring Your Energy Use!** Pre-Assignment that will prompt thought about energy usage. In short, the worksheet will:

- Ask students to look for all the things in their house that are plugged in
- Ask students if all those things need to be plugged in
- Ask students to think about other ways their family uses energy
- Ask students where they think all that energy comes from

Activity One: *The Coal Mine Calamity*

1. **Play** 'Searching for Coal'
    a. Push all desks, chairs, and other furniture to the corners of the room
    b. Have students take off their shoes and pile them high in the middle of the room, shaped like a mountain.
    c. Somewhere in the middle of the pile, hide ten bandanas of different colors. The shoes symbolize the mountain, four of the bandanas (black) symbolize coal, two (red) symbolize someone in the nearby town getting a respiratory illness, two (blue) symbolize the water supply being contaminated with toxic chemicals, and two (green) symbolize the surrounding farmland being destroyed.
    d. Blindfold one student, and tell him/her that s/he is a coal miner. S/he has to find a 'ribbon of coal' in the mountain of shoes, while trying not to destroy the mountain in the process. This will be, more or less, impossible.
    e. Steer him/her toward the mountain of shoes and let him/her dig through the pile (trying not to wreck it) until s/he pulls out a bandana.
    f. Discuss what the student found (it might not be coal).
    g. Americans don't stop needing energy! Blindfold a new student and have them 'dig for coal.'
    h. For different options that don't involve dirty shoes, see **Appendix -** Alternatives to Using Shoes.

[6] U.S. Department of the Interior. 1979. *Permanent Regulatory Program Implementing Section 501(b) of the Surface Mining Control and Reclamation Act of 1977: Environmental Impact Statement*. Washington, D.C.: U.S. Department of the Interior.

2. **Discuss** the effects of coal mining:
    a. What did the 'mountain' look like at the end of the activity?
    b. Even though the miners were cautious, the pile was still destroyed. Given that most states have few mining laws, what would the mountain look like if the miners had not been cautious?
    c. What if there was a nearby town or river next to the mountain? What would happen to these sites after the mountain was destroyed?

3. **Discuss and/or calculate** the amount of coal used in the U.S. each year (*Note: Section 'b' below contains more advanced concepts to be done in place of or as an extension to the discussions in Section 'a', or it can be skipped entirely depending on the students' abilities and the timeframe of the class).*
    a. **Discuss** how nearly half of the energy used in every American household comes from coal.
        i. On average, each American household uses almost 1,800 pounds of coal per year. Pass around an object that weighs about 1 pound, and talk about how much 1,800 pounds would be.
        ii. Next, talk about the number of people in each American household (average of 2.61). If two or three people live in each house, think how many pounds of coal are being used by just one person per year (about 688 pounds). How old are your students? How many years have they been using that much energy?
        iii. Also, have students ponder the difference between individual energy usage and household energy usage. For example, it uses the same amount of energy to heat a house whether one person lives there or eight. Also, think about the energy used by individuals outside of the home (ex. transportation, offices and factories, production of materials, etc.)
        iv. Extend these concepts by having each student think of his/her neighborhood, subdivision, town or city, and then imagine how many houses and people there are in neighborhoods, towns and cities all around the United States. That's a lot of households and people using a lot of coal!
    b. **Have students calculate** the raw numbers and compare their results with the following statistics:
        i. The average American household consumes 11,000 kilowatt-hours of energy per year.[7] If 49% of that is from coal, how many kilowatt-hours of coal does each household use per year? *(Answer: 5,390 kilowatt-hours per household per year)*
        ii. If a pound of coal produces around 3 kilowatt hours of energy[8], how many pounds of coal does the average household use in a year? *(Answer: 1,796.777, or approximately 1,797 pounds of coal per household per year from coal)*
        iii. There are 2.61 people on average in each U.S. household[9] - how many kilowatt hours of coal does each person burn through? *(Answer: 2065.134, or approximately 2,065 kilowatt hours of coal per person)*

[7] http://www1.eere.energy.gov/consumer/tips/appliances.html
[8] http://www.uwsp.edu/CNR/wcee/keep/Mod1/Whatis/energyresourcetables.htm
[9] http://www.uwsp.edu/CNR/wcee/keep/Mod1/Whatis/energyresourcetables.htm

iv. If a pound of coal produces around 3 kilowatt hours of energy[10], how many pounds of coal does the average person use in a year? *(Answer: 688.378, or approximately 688 pounds of coal per person)*
v. If each kilowatt-hour of coal used produces 1.9 pounds of carbon emissions. How many pounds of CO_2 does your coal addiction release each year? *(Answer: 3,923.7546, or approximately 3,924 pounds of CO_2 per person per year)*
vi. There are 301,139,947 people in the U.S.[11] How many tons of coal does the U.S. need to provide energy for these houses in one year? (*Answer: 207,298,114,436 pounds of coal, or 103,649,057.218 tons – there are 2,000 pounds in 1 ton – and 39,712,282.459 tons per household).* Remember, this doesn't include factories or office buildings!
vii. Have students discuss why energy usage statistics can vary widely depending on how they are calculated. For example, calculating by household does not account for energy used outside the home, or for the number of individuals per household. Similarly, calculations per individual usually do not account for energy used in communal spaces or infrastructure.

c. **Relate** the concepts discussed above to the consequences for the earth.
i. In total, the U.S. uses 2,257,600,000,000 lbs of coal per year[12] - that's 1,128.800 million tons.
ii. Present a picture of Kayford Mountain after being mined for coal (see Reproducible #2 - **Kayford Mountain Photo**). It is estimated to contain 52 million tons of coal.[13] How many mountains do we need to destroy every year to keep up with how much energy the U.S. needs? (*Answer: 21.708, or the equivalent of about 22 Kayford Mountains need to be destroyed to meet U.S. coal needs each year*)
iii. Imagine if one of these 22 mountains were near your home!

4. **Discuss** the natural impacts of coal mining and use:
a. Environmental impacts
i. Surface mining of coal completely eliminates existing vegetation, destroys the genetic soil profile, displaces or destroys wildlife and habitat, degrades air quality, alters current land uses, and to some extent permanently changes the general topography of the area mined.[14] This often results in a scarred landscape with no scenic value, though rehabilitation can mitigate some of these concerns.
ii. Mine tailing dumps produce acid mine drainage which can seep into waterways and aquifers, with consequences on ecological and human health.
iii. The collapse of underground mine tunnels can cause subsidence (downward shifting or caving) of land surfaces.

---

[10] http://www.uwsp.edu/CNR/wcee/keep/Mod1/Whatis/energyresourcetables.htm
[11] https://www.cia.gov/library/publications/the-world-factbook/print/**us**.html
[12] http://www.eia.doe.gov/cneaf/coal/page/special/feature.html
[13] http://www.coalriverwind.org/wp-content/uploads/2008/07/crm_factsheet.pdf
[14] U.S. Department of the Interior. 1979. *Permanent Regulatory Program Implementing Section 501(b) of the Surface Mining Control and Reclamation Act of 1977: Environmental Impact Statement*. Washington, D.C.: U.S. Department of the Interior.

iv. During actual mining operations, a potent greenhouse gas, methane, may be released into the air.
v. By the movement, storage, and redistribution of soil, the community of microorganisms and nutrient cycling processes can be disrupted.
vi. In addition to the production of coal, there are also significant environmental issues associated with its use, including air pollution, global warming and acid rain.

b. Health effects
   i. Asthma is on the rise in towns near blasting zones. Contaminated water, along with structural dangers to homes, have caused property values to plummet and have forced many living for generations on family plots of land to leave.
   ii. The EPA estimates that nearly 70% of the wells near mountaintop-removal sites on the Appalachian Plateau test high for iron and manganese water concentrations.
   iii. After it is burned, coal's emissions and particle pollution greatly reduce air quality, contributing to respiratory illness and poor health.

Activity Two: *Turn It Up*
Watch The Gorilla in the Greenhouse film, "Turn It Up" on Earth Day TV at www.earthdaytv.net

Activity Three: *How many planets would we need?*

1. Direct students to the Earth Day Network ecological foot print calculator at www.earthday.net/ecofootprint.

2. Have students **take the online quiz**, and then write on the white board or chalk board their name and how many planets we would need to support their lifestyle.

3. **Average** the class results from the quiz and **discuss**.

4. **Discuss** sustainability, and whether or not the class' way of life is sustainable.

Wrap Up: *Fix the Problem!*

1. **Get on the internet** at http://www.ilovemountains.org/myconnection/ and type in the zip code of your school. The website will tell you how you contribute to mountaintop removal. This might be a mine or coal power plant in your area, or if you invest in a bank that invests in coal.

2. **Provide success stories** of cities, states, and countries that are fighting for renewable energy:
   a. **Governor Sebelius** of Kansas[15] - for the first time ever, a government agency rejected the construction of a huge coal plant on the grounds that carbon dioxide is a pollutant regulated under the Clean Air Act.
   b. **Sierra Club** wins ruling against the EPA[16]

[15] http://www.ens-newswire.com/ens/may2008/2008-05-16-093.asp

i. Environmental Protection Agency's Environmental Appeals Board (EAB) ruled that the EPA had no valid reason for refusing to limit the carbon dioxide emissions from new coal-fired power plants that cause global warming. The decision means that all new and proposed coal plants nationwide must address their carbon dioxide emissions.
ii. The Sierra Club achieved this ruling by going before the Environmental Appeals Board in May of 2008 to request that the air permit for Deseret Power Electric Cooperative's proposed waste coal-fired power plant be overturned because it failed to require any controls on carbon dioxide pollution.

c. **Maria Gunnoe**[17]
   i. After living in a town that had been destroyed by a local mountain top removal coal mine, Maria took her story to the public to raise awareness about how much harm coal mining can really do.
   ii. Maria faced intense social pressure from her neighbors to stop her campaign, deemed bad for the local coal economy.
   iii. Maria lobbied and organized her community until the EPA filed a suit against Massey Energy Company. In what has become the largest Clean Water Act settlement to date, the company agreed to a $20 million settlement with the EPA to resolve thousands of violations of the Clean Water Act for routinely polluting waterways in Kentucky and West Virginia with coal slurry and wastewater.

3. **Have students discuss** various ways in which they can reduce the amount of energy used in their homes. Make sure they touch on:
   a. Turning off lights when they aren't in use
   b. Setting the thermostat lower
   c. Unplugging computers, TVs, cable boxes, and other "energy vampire" appliances when not in use
   d. Using fewer materials
   e. Using reusable items so energy isn't wasted in production

Extension: *You Can Make a Difference*
Have students choose between three creative tasks:

f. **Design a poster** to post around the school, showing one energy-saving tip to reduce energy at home and at school. Find ideas at www.earthday.net
g. **Write a letter** to the local energy company, asking them to use more renewable energy and less coal energy.
h. **Write an Action Plan** for your own house to reduce energy usage. These must include specific actions, time frames, and assignments of who is responsible for each task.

Additional Activities:

---

[16] http://action.sierraclub.org/site/MessageViewer?em_id=78902.0
[17] http://www.stopmountaintopremoval.org/marias-story.html

A. Switch Your Energy Provider!
Have students research the possibility of buying alternative energy! Their families can buy solar panels or residential wind turbines on their own, or choose to switch energy providers to one that provides an option for choosing renewable energy, such as Pepco: http://www.pepcoenergy.com/ProductsAndServices/productCategory.aspx?Market=Residential&MarketCode=Residential&MarketId=1&CategoryId=1

B. Coal Mining Education Week
To raise awareness, have classrooms compete to see who can save the most energy. There will be points assigned for every action:

- 3 points for every full recycling bin
- 5 points for generating no trash each week
- 3 points for every hour of using only ½ the lights in the classroom
- 6 points for every hour of having no lights on in the classroom
- 2 points for every time the computer is unplugged overnight
- 1 point for every 5 students who bring their lunches to school in a reusable lunch bag
- 1 point for every degree below 69 per hour that the thermostat is turned down

CONCLUSION

Most students don't make the connection between switching on a light and destroying the top of a mountain. By the end of this lesson, that link should be clear in their minds. The students will have assessed all the harmful environmental and health impacts of mining for coal, and participated in a hands-on activity that makes that association even more direct. After learning all of coal's negative attributes, students will be trained in all the positive ways in which they can help the situation, and will hopefully be left with a feeling of motivation and empowerment.

Appendix - Alternatives to Using Shoes

Play 'Searching for Coal' using **BOOKS**

c. Push all desks, chairs, and other furniture to the corners of the room
d. Pile all the books in the classroom in a pile, (some history, some math, some English, some science).
e. The history books will symbolize the mountain, as mountains are very old and contain a lot of history. The English books symbolize a small child getting asthma due to the clouds of dust coming from the exploded mountain. The math books symbolize a water source for the nearby town getting contaminated, and the science book symbolize finding coal.
f. Blindfold one student, and tell him/her that he/she is a coal miner. He/she has to pull one book off of the mountain, hoping that it will be coal.
g. Discuss what the student found (it might not be coal). If it is coal, move on to the next student. If it is a part of the mountain, discard the book nearby and move on to the next student. If it is anything else, explain this environmental or health effect to the class, then move on to the next student.
h. Americans don't stop needing energy! Blindfold a new student and have them 'dig for coal.'

Play 'Searching for Coal' using **actual dirt**

i. Take the student outside, and using shovels make a large pile of dirt shaped like a mountain.
j. Somewhere in the middle of the dirt pile, hide ten bandanas of different colors. The dirt symbolizes the mountain, four of the bandanas (black) symbolize coal, two (red) symbolize someone in the nearby town getting a respiratory illness, two (blue) symbolize the water supply being contaminated with toxic chemicals, and two (green) symbolizes the surrounding farmland being destroyed by toxic chemicals.
k. Blindfold one student, and tell him/her that s/he is a coal miner. S/he has to find a 'ribbon of coal' in the mountain of dirt, while trying not to destroy the mountain in the process. This will be, more or less, impossible.
l. Steer him/her toward the mountain of dirt and let him/her dig through the pile (trying not to wreck it) until s/he pulls out a bandana.
m. Discuss what the student found (it might not be coal).
n. Americans don't stop needing energy! Blindfold a new student and have him/her 'dig for coal.'

At Home: Monitoring Your Energy Use!

Take a moment to count everything in your house that uses energy. How many can you find? List at least 10.

1.)	2.)	3.)	4.)
5.)	6.)	7.)	8.)
9.)	10.)	11.)	12.)

Does everything in your house need to be plugged in? What is wasting energy when it's unnecessarily plugged in?

Besides machines and appliances that are plugged in, how else does your family use energy?

1. _____
2. _____
3. _____
4. _____
5. _____

Where do you think we get our electricity? Where does it come from?

_____
_____
_____
_____
_____
_____

Kayford Mountain Photo

This is Kayford Mountain, after being mined for coal.