This Mine of Mine

This hands-on activity allows students to explore the formation, geology, recovery, economics, and uses of coal, as well as the reclamation of mine sites.

Grade Level:

- **Pri** Primary
- **Elem** Elementary
- **Int** Intermediate

Subject Areas:

- **Science**
- **Social Studies**
- **Technology**
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NEED Mission Statement

The mission of The NEED Project is to promote an energy conscious and educated society by creating effective networks of students, educators, business, government and community leaders to design and deliver objective, multi-sided energy education programs.

Teacher Advisory Board Statement

In support of NEED, the national Teacher Advisory Board (TAB) is dedicated to developing and promoting standards-based energy curriculum and training.

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Energy Data Used in NEED Materials

NEED believes in providing the most recently reported energy data available to our teachers and students. Most statistics and data are derived from the U.S. Energy Information Administration’s Annual Energy Review that is published yearly. Working in partnership with EIA, NEED includes easy to understand data in our curriculum materials. To do further research, visit the EIA web site at www.eia.gov. EIA’s Energy Kids site has great lessons and activities for students at www.eia.gov/kids.
This Mine of Mine

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Standards Correlation Statement

www.NEED.org/curriculumcorrelations

Next Generation Science Standards

- This guide effectively supports many Next Generation Science Standards. This material can satisfy performance expectations, science and engineering practices, disciplinary core ideas, and cross cutting concepts within your required curriculum. For more details on these correlations, please visit NEED's curriculum correlations website.

Common Core State Standards

- This guide has been correlated to the Common Core State Standards in both language arts and mathematics. These correlations are broken down by grade level and guide title, and can be downloaded as a spreadsheet from the NEED curriculum correlations website.

Individual State Science Standards

- This guide has been correlated to each state's individual science standards. These correlations are broken down by grade level and guide title, and can be downloaded as a spreadsheet from the NEED web site.

Curriculum Correlations

NEED has correlated all of their materials to The Common Core State Standards for English Language Arts and Mathematics. NEED has also correlated its materials to each state’s individual science standards.

All files are in Excel format. NEED recommends downloading the file to your computer for use. Save resources, don't print!

- Common Core State Standards for English Language Arts
- Common Core Standards for Mathematics
  - Alabama
  - Alaska
  - Arizona
  - Arkansas
  - California
  - Colorado
  - Connecticut
  - Delaware
  - Florida
  - Georgia
Read the entire procedure for all activities before gathering or purchasing supplies. Gather supplies using the table below and organize materials into several work stations for each activity.

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>MATERIALS NEEDED</th>
<th>DESCRIPTION/AMOUNT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Land Development</strong></td>
<td>• Small plastic bowls</td>
<td>• At least one per student</td>
</tr>
<tr>
<td></td>
<td>• Plastic spoons</td>
<td>• One per student</td>
</tr>
<tr>
<td></td>
<td>• Large plastic bowls</td>
<td>• Several, for putting materials in at work stations</td>
</tr>
<tr>
<td></td>
<td>• 5 lb Bag of sand</td>
<td>• Works best if damp</td>
</tr>
<tr>
<td></td>
<td>• 5 lb Bag of small, gray pebbles</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• 5 lb Bag of small, white pebbles</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• 5 lb Bag of topsoil</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• 5 lbs of Clay</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• 50-100 Small pieces of coal or black pebbles</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Table coverings</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Grass, leaves, twigs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Markers</td>
<td></td>
</tr>
<tr>
<td><strong>Geology, Mining, and Reclamation</strong></td>
<td>• Clear straws</td>
<td>• At least one per student</td>
</tr>
<tr>
<td></td>
<td>• Grass seed</td>
<td>• Small amount, any seed</td>
</tr>
<tr>
<td></td>
<td>• Top soil</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Coal container</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Table coverings</td>
<td></td>
</tr>
<tr>
<td><strong>Coal Mining Challenge</strong></td>
<td>• Wooden toothpicks</td>
<td>• 1 Box</td>
</tr>
<tr>
<td></td>
<td>• Plastic toothpicks</td>
<td>• 1 Box</td>
</tr>
<tr>
<td></td>
<td>• Large paper clips</td>
<td>• 20-30</td>
</tr>
<tr>
<td></td>
<td>• Napkins or paper towels</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Play money</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Chocolate chip cookies</td>
<td></td>
</tr>
<tr>
<td></td>
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</tbody>
</table>
Background
Coal generates about 40% of our nation's electricity. This activity allows students to explore the formation, geology, recovery, and uses of coal, as well as the reclamation of coal mine sites. Using sand, clay, soil, and rocks, students build a miniature plot of land containing coal deposits. Students then learn about the surface mining method of recovering coal from the Earth, and practice the method on their plot of land. After the coal is mined, students reclaim the plot of land and discuss how the coal is transported and used.

Objective
Students will be able to describe the process and challenges of mining and reclamation.

Concepts
• Some geographic areas have more coal than others.
• Coal on or near the surface is easier to mine than coal buried deep underground.
• Land is reclaimed after mining, and it can be a difficult process.
• Just like our bodies burn the calories (chemical energy) in a chocolate chip for energy to move, coal is burned turning chemical energy into electricity.
• Just like the food we eat, once coal is burned we cannot use it again. It takes the Earth a very long time to produce more coal – it is nonrenewable.

Activity 1: Land Development

Preparation
1. Prepare copies of Formation and Source Mining (pages 12 and 13) to project for the class.
2. Make copies of the Land Development Worksheet, Coal Chain, Mining Challenge, and Assessment for each student (pages 14-19).
3. Gather infobooks, or make copies of the coal infosheet from the appropriate level infobook. Infobooks can be downloaded in PDF format from www.NEED.org. You may also choose to make a copy of the geothermal infosheet to project for discussion, as it showcases the layers of the Earth.
4. Set up work stations with the necessary materials (see page 5) so that students will have access to all supplies.
5. Cover the student work areas with newspaper or plastic.
6. Place one large bowl each of sand, gray pebbles, white pebbles, and topsoil at each station, as well as a portion of clay, a small bowl of coal, and a plastic spoon. Hint: The activity is more successful if the sand is slightly moist—the consistency of brown sugar.

Procedure
1. Have the students read the coal infosheet in the Elementary Energy Infobook. Project the Formation master and discuss the formation of coal. Also discuss its significance as an energy source in the United States, especially in the generation of electricity.

Note: For older or younger students, you may also direct them to the Primary or Intermediate Energy Infobook.
2. Review the following vocabulary words:
   - **coal**: a black mineral that can be burned for energy
   - **mine** (verb): to remove natural resources from the ground by digging
   - **surface mining**: removing layers of earth to recover a natural resource
   - **natural resource**: something in nature that can be used to improve lives
   - **reclamation**: returning disturbed land back to the way it was

3. Explain to the students that they will build their own plots of land that contain coal deposits.

4. Discuss how the Earth is made of layers of different materials. (See the geothermal infosheet in the infobook for a diagram of the major layers of the Earth.) In this activity, the layers in the crust are represented by sand, clay, soil, and pebbles.

5. Provide each student with a small plastic bowl and spoon. Have the students write their names on the bottoms of the bowls with markers, then send them to the work stations.

6. Distribute the *Student Guide* worksheets and review the steps using the script below. The worksheets do not include the exact same script or the explanation of geological layers as described below:
   - Get a lump of clay about the size of your fist, or a bit smaller.
   - Roll the clay flat and press it into the bottom of your container. *This represents the clay layer in the Earth.*
   - Place one spoonful of coal on an area of the clay and flatten it. (This coal layer should not be distributed evenly throughout the clay; it should take up only a small area of the clay.) *This represents a seam of coal on top of the clay layer.*
   - Spread 6 spoonfuls of gray pebbles on top of the coal. Make a hill with the pebbles. *This represents the shale that typically covers a layer of coal.*
   - Spread 7 spoonfuls of white pebbles evenly in the container. *This represents a layer of limestone.*
   - Spread 8 spoonfuls of gray pebbles evenly on top of the white pebbles. *This represents another layer of shale.*
   - Spread 10 spoonfuls of sand evenly on top of the pebbles. *This represents sandy, rocky soil.*
   - Spread 12 spoonfuls of topsoil evenly on top of the sand. *This represents fertile topsoil.*
   - Use cut grass, leaves, and twigs to make fields and forests on your plot of land.

7. After the students have finished their plots of land, have them clean up and store them until tomorrow. The topsoil, grass seeds, and spoons will be needed again.

8. Review and discuss how the Earth is made of layers of different types of rocks, topsoil, clay, and water. Some of these layers contain natural resources that we use for many different things. Have the students look at the geothermal infosheet in the infobooks to see the diagram of the Earth's layers.
Activity 2: Geology, Mining, and Reclamation

Preparation

1. Set up and cover work stations with newspaper or plastic and put bowls of topsoil and grass seed at each station. Place clear drinking straws and spoons at each station.

Procedure

Geology and Mining

1. Discuss with the students things they use that are made from natural resources found underground, such as:
   - pencils made from graphite
   - jewelry made from gold, silver, gemstones
   - plastic items made from petroleum
   - nylon and polyester clothes made from petroleum
   - anything metal
   - coal used to generate electricity
   - natural gas, petroleum, and uranium used to generate electricity
   - steam from geysers—geothermal energy

2. Discuss how we remove coal and other natural resources buried in the Earth, using the Source Mining master.
   Make a KWL chart about mining. On the board, chart, or digital document, draw a table with three columns. Label the columns K, W, and L.
   Ask what the students know about mining, and record their responses in the K column.
   Ask what the students want to know about mining, and record the responses in the W column. Tell the students they can add to this column at any time.
   Leave the L column blank. The students will add to this column during and after the activities as they learn new information.

3. Have students retrieve their plots of land and return to the work stations. Explain that they will be mining the coal from their plots of land.

4. Instruct the students to take core samples of their plots, using drinking straws to carefully probe the soil. Explain how to cover the end of the straw with a finger and carefully remove the straw to look at its contents. If the pebbles are too large, this step of the activity will not work.

5. The students must use their spoons to carefully remove each layer of grass, sand, and pebbles, placing each layer in a separate pile on the workstation. This simulates the use of bulldozers and other machines to move layers of earth.

6. When the coal layer is reached, the spoons should be used to remove the coal. Have the students place the coal in a coal container you designate. A toy dump truck or train car works nicely.

7. When the mining is complete, discuss with the students what they have learned in the mining process and what questions they still have. Have students add to the W and L columns on the KWL chart.

Reclamation

1. Discuss with the students whether or not they should leave the plots of land as they are after mining. Introduce the concept of reclamation. By law, mine sites must be restored to a state that is as good as, or better than, it was before mining.

2. Direct the students to reclaim their plots of land. They should replace all of the layers so that they are the same as they were before the land was mined, except for the grass, leaves, and twigs, which must be thrown away because they are dead. New growing things must be planted.

3. When they have replaced the dirt layer, have them sprinkle two pinches of grass seed onto the soil, then cover the seeds with a layer of topsoil. Have them water the soil and place the plots of land in a sunny area.
4. Clean up the work stations. Bring the class back together to discuss the reclamation process and add to the KWL chart. Lead the discussion by asking the following questions:

Was it easy to replace each layer exactly as it was? Reclamation is difficult and expensive. Imagine if the plots of land in our experiment were as big as our playground or school yard. It would take time and effort to replace the land.

Why is it important to reclaim mined land? The resources we get from the Earth are important to our lives. The environment that surrounds and covers those resources is equally important. It is our responsibility to return the land to a state that is as good as, or better than, it was before we removed the resources.

What happens when land is not reclaimed? What did our room look like right after we had mined our coal? It was a mess! We couldn’t use it for the things we needed to do in our room. We needed to clean it up so that it was useful to us again. It is important to respect the Earth. Land that is not reclaimed ends up being an empty pit. It is ugly, can’t be used, and can sometimes be dangerous. Reclaimed land can be used for farmland, camping, lakes, planting trees, livestock grazing, homes, golf courses, and many other things.

Could you plant trees and build homes on the site as soon as the Earth is reclaimed? It depends on many factors. The depth of the mine, the weather, and the type of soil in the mine can affect how long it takes before the land can be used for planting trees and building safe structures. Have the students compare how their plots looked before and after they added water.

**Activity 3: The Coal Chain**

✔️ **Procedure**

1. Have the students add to the W and L columns of the KWL chart the things they learned about reclamation in the previous day’s activity, and things the activity made them want to know more about.

2. Discuss and/or demonstrate what happens to coal after it is mined: The coal is transported by train, barge, or truck to the power plant; the coal is cleaned of impurities; the coal is burned in the boiler of the power plant; the heat from the burning coal is used to heat water into steam; the steam rushes through a pipe and spins a turbine; the turbine is connected to a generator that produces electricity; the electricity travels by power lines to businesses and homes.

3. Have the students complete the Coal Chain activity on page 15.

4. Use *A Cool Coal Story* in NEED’s *Energy Stories and More* to have students act out the formation and mining of coal, and its use to generate electricity.

**Activity 4: Coal Mining Challenge**

 chắn **Preparation**

1. Split up students into teams of 3-5 students.

2. Separate the play money for each team so that each group has varied denominations adding up to $105.

3. Select 3 students or helpers to serve as the banker, equipment company salesman, and realtor.

4. Set up work stations or areas where teams can purchase materials and do their mining.

✔️ **Procedure**

1. Pass out the student worksheets for the activity.

2. Preview the rules of the activity and the steps each group will need to follow. For younger students, you may choose to have a sample page completed ahead of time to project so students can work through the process and see the calculations they will make.

3. Help teams pick their jobs or roles and determine how many mine sites and tools they want to purchase. For younger students, it is recommended that each team only purchase one mine site. Older students may purchase more, but they will also need extra grid space. If allowing teams to purchase more than one mine (cookie), you may consider giving teams more than the prescribed amount of play money.
4. Hand out cookies as students visit the realtor to purchase their mines. Instruct the teams that these cookies are just for mining and that they should not be eaten until AFTER the activity. Make sure each team maps out their mine on their grid.

5. Direct the teams to begin mining. Keep time for the 1-minute shifts and moderate as teams are determining their earnings and/or buying supplies. Give the signal for when teams should start each shift. Make sure teams are mining only the number of shifts they have selected to mine. You may choose to pre-determine the number of shifts each team will have to do their mining.

6. As teams finish their shifts remind them to begin the reclamation process. Assist landmen in assessing fines to their teams.

7. Direct the teams to help their accountant tally up their final balances.

8. Discuss the profits and losses each team faced. Ask students why they might have had losses despite mining plenty of coal. What challenges did they face during reclamation?

9. Allow students to eat cookies.

**General Rules of the Challenge:**

1. Each team tries to mine the most coal (chocolate chips) from their mine (cookie).
2. Each team member has a job and must keep that job throughout the game.
3. Cookies must be mined with the tools purchased only – NO hands!
4. Teams must mine in 1-minute shifts. No mining should take place between the timed shifts.
5. After each team finishes their shift allotment, they must reclaim the land using their original outline map.
6. Teams should tally up their total costs and earnings to determine net profit/loss.

**Jobs:**

- **Banker:** Handles all money, gives each team their initial investment. Makes change and pays out after each shift.
- **Equipment Salesman:** Sells teams their tools before mining and during shifts.
- **Realtor:** Sells teams their mine, hands out cookie.
- **Landman:** Purchases mine land from realtor. Determines which tools will be used and purchased. Outlines/maps out their mine land on the grid. Oversees reclamation.
- **Accountant:** Tracks the expenditures and income of the team. Completes the worksheet table and calculates the final balance. Determines how much coal is mined in each shift. Goes to the banker to seek pay.
- **Miners:** Responsible for mining the coal and reclaiming the land.

**Finances:**

- Each team receives $105 as an initial investment
- Each mine (cookie) costs $20
- Tools have varying costs: wooden toothpick $1, plastic toothpick $2, and paper clip $3
- Each team must pay EACH miner $15 for each minute-long shift they work
- For every ton (square) of coal, teams earn $5 (square must be at least half-full)
- After reclamation, any land outside the original outline of the mine will be assessed a $1 fine for each square
Extensions

1. Invite a representative from a local coal company or electric utility to the classroom to discuss the coal industry and help the students answer more of the W questions on the KWL chart.

2. Have the students precisely measure all of the materials used in their plots of land by weight or volume, or both, and record the data before and after the activity.

3. Have the students draw maps of their plots, showing where the coal is located.

4. Rather than providing copies of page 14, give students blank cross-sections of plots and have them label and color the layers. Instruct the students to use their diagrams during the reclamation activity.

5. Search NEED’s Energy Booklist for fiction and nonfiction titles about coal and mining.

Assessment

1. Review the KWL chart and have students complete the Assessment on page 19.

2. Evaluate the activities with the students using the Evaluation Form on page 20 and return it to NEED.
How Coal Was Formed

Before the dinosaurs, many giant plants died in swamps.

Over hundreds of millions of years, the plants were buried under water and dirt.

Heat and pressure turned the dead plants into coal.

*This diagram shows deep coal mining. Coal formations can also be found close to the surface. This coal is mined by surface mining.*
Source Mining

Surface Mining

Deep Mining
Follow these steps to build your plot of land. Check off each step in the box on the left as you do it.

- Get a lump of clay about the size of your fist or a bit smaller.
- Flatten the clay into the bottom of your container.
- Place 1 spoonful of coal in any area of the clay and spread it flat.
- Spread 6 spoonfuls of gray pebbles over the coal, making a small hill.
- Spread 7 spoonfuls of white pebbles evenly into the container.
- Spread 8 spoonfuls of gray pebbles evenly into the container.
- Spread 10 spoonfuls of sand evenly into the container.
- Spread 12 spoonfuls of topsoil evenly into the container.
- Use cut grass, leaves, and twigs to make fields and forests on the top.

This is what your plot of land should look like:
Coal Chain

Number the circles from 1 to 6 to show the chain of coal from its formation to its use in your home. On a separate page, write a sentence to explain each number.
Objective
You will work in teams of 3 to 5. Each team will become a mining company. Your company wants to mine as much coal (chocolate chips) from your mine (cookie) as possible. Each team will be given a starting investment of $105.00 to purchase land, equipment, and pay their miners. There will be a class banker, equipment salesman, and realtor who sells the land to be mined. A list of costs includes:

- Each mine will cost $20.00 to purchase
- Wooden tools will cost $1.00 each to purchase
- Plastic tools will cost $2.00 each to purchase
- Metal tools will cost $3.00 each to purchase
- Each miner must be paid $15.00 for each shift
- Each ton (square) of coal mined is worth $5.00
- Land outside the original mine after reclamation will cost $1.00 (per square)

Procedure
1. Each team member will assume a role in the company. Read the job descriptions below and write each team member’s name on the line next to the job he/she has picked.

   The landman (1 team member) is responsible for purchasing the land to be mined and determining which tools the team will purchase. They will also survey the boundaries of the mine, outlining the land boundaries on the grid. When the mining shift ends, they will oversee reclamation of the land.

   Landman

   The accountant (1 team member) is responsible for tracking the expenses and income of their company.

   Accountant

   The miners (1-3 team members) are responsible for ‘mining’ the coal and reclaiming the land.

   Miner 1

   Miner 2

   Miner 3

2. Decide how many mines ($20.00 each) your company wants to purchase and what mining supplies you wish to purchase.

3. Determine how many 1-minute shifts your team will use to complete the mining.

4. Mine your land (cookie) during the timed shifts. Remember, you may ONLY use the tools purchased to do your mining – NO HANDS! Try to recover as much coal (chocolate chips) as possible during each shift. At the end of each minute shift, place your coal in the grid to be counted. Each ton will earn you a payout. A square must be at least half-full to count as a ton. Tally up labor costs to pay the miners. Your accountant will keep track of your funds earned and paid.
5. Once your team has mined for the number of shifts you selected, you must reclaim your land. Try to piece your cookie together so that the land is as good as, or better than, it was before.

6. The landman will determine if any land is outside the original mine and fine your team $1.00 for any land leftover outside of the original mine outline.

7. Help your accountant total up your expenses and earnings and complete the final balance.

**Data**

Name of your company:_________________________ Beginning Balance: $_________________

<table>
<thead>
<tr>
<th>EXPENSES</th>
<th>QUANTITY</th>
<th>UNIT PRICE</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mine Site</td>
<td></td>
<td>$20.00</td>
<td></td>
</tr>
<tr>
<td>Wooden Toothpick</td>
<td></td>
<td>$1.00</td>
<td></td>
</tr>
<tr>
<td>Plastic Toothpick</td>
<td></td>
<td>$2.00</td>
<td></td>
</tr>
<tr>
<td>Paper Clip</td>
<td></td>
<td>$3.00</td>
<td></td>
</tr>
<tr>
<td>Labor Costs</td>
<td></td>
<td>$15.00 per shift</td>
<td></td>
</tr>
<tr>
<td>Reclamation</td>
<td></td>
<td>$1.00 per square</td>
<td></td>
</tr>
</tbody>
</table>

**Area of Mine Site**

Outline your mine (cookie) on the grid below.

Put mined coal (chips) here.

Income from coal: ________________

$5 per ton (square must be at least half-full to be counted as a ton)
## Final Balance

<table>
<thead>
<tr>
<th>Step 1</th>
<th>Step 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beginning balance</td>
<td>Current balance</td>
</tr>
<tr>
<td>$_________________</td>
<td>$_________________</td>
</tr>
<tr>
<td>Minus expenses</td>
<td>Plus income from coal</td>
</tr>
<tr>
<td>$_________________</td>
<td>$_________________</td>
</tr>
<tr>
<td>Current balance</td>
<td>Ending balance</td>
</tr>
<tr>
<td>$_________________</td>
<td>$_________________</td>
</tr>
</tbody>
</table>

Did your company make a profit or suffer a loss? (+ or -)  $_________________                       

What was your profit/loss amount?  $_________________                       

This Mine of Mine
Assessment

Answer each question with a complete sentence.

1. What is a natural resource?

2. Why is coal a nonrenewable resource?

3. How was coal formed?

4. Where do we find coal?

5. How do we get coal?

6. Why is it important to reclaim land after it is mined?

7. How do we use the energy in coal?
This Mine of Mine Evaluation Form

State: ___________  Grade Level: ___________  Number of Students: __________

1. Did you conduct all of the activities?  
   - Yes  - No

2. Were the instructions clear and easy to follow?  
   - Yes  - No

3. Did the activities meet your academic objectives?  
   - Yes  - No

4. Were the activities age appropriate?  
   - Yes  - No

5. Was the allotted time sufficient to conduct the activities?  
   - Yes  - No

6. Were the activities easy to use?  
   - Yes  - No

7. Was the preparation required acceptable for the activities?  
   - Yes  - No

8. Were the students interested and motivated?  
   - Yes  - No

9. Was the energy knowledge content age appropriate?  
   - Yes  - No

10. Would you teach these activities again?  
    - Yes  - No

Please explain any ‘no’ statement below.

How would you rate the activities overall?  
   - excellent  - good  - fair  - poor

How would your students rate the activities overall?  
   - excellent  - good  - fair  - poor

What would make the activities more useful to you?

____________________________________________________________________
____________________________________________________________________
____________________________________________________________________

Other Comments:

____________________________________________________________________
____________________________________________________________________
____________________________________________________________________

Please fax or mail to:  The NEED Project
   P.O. Box 10101
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