Hydraulic Fracturing Our Nation

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Introduction

Fracking is a hot topic that is frequently in the news these days. Rarely a week goes by that I do not see a contentious article either supporting or decrying the practice of fracking. But what exactly is fracking, why is it controversial and more importantly, why should we care?

The last question about "caring" initially is what led me to fracking. During my Human Population Growth seminar with Dr. Jack Bartley at the University of Delaware, we explored a number of environmental concerns caused by increased population. One in particular that struck me was the use of hydraulic dams on the Columbia River for electric power. In order to survive, salmon need to migrate from fresh water streams to the ocean, and back again. I learned that the Columbia River was once thought to produce the greatest amount of salmon in the world. Salmon are born at the bottom of freshwater streams, grow a few inches, and then must migrate downstream to estuaries before they head out to sea. They spend a few years in the ocean before returning to their home stream to spawn. The problem with the Columbia and other rivers is that some dams were built with no way for the salmon to get either down or upstream. While I knew there were dams along the Columbia River, I did not realize the extent of which they hindered the migration of steelheads and salmon. Energy production and consumption is complex. On one hand, it is a necessity for a growing population, yet at what cost to our environment are we willing to pay?

Since the Industrial Revolution, our energy demands have risen continuously. The majority of this energy has come from fossil fuels such as coal and natural gas. Hydraulic fracturing, or fracking as we call it, is a technique to recover natural gas from shale rock. In simplified terms, during fracking incredible amounts of sand, water and chemicals are injected with high pressure deep into the shale rock layers thus releasing the trapped gas inside.

While fracking has been used since the 1940s, we have seen a significant boom in the last ten years, especially in the United States. Many of our resources for natural gas are steadily being depleted and, in turn, prices are becoming increasingly expensive. As we look to alternative means to acquire natural gas, fracking is starting to look more appealing and revolutionizing the energy industry. Many articles I have read on fracking seemed straight forward; however, there are countless nuances which shift people's perceptions of whether fracking is safe or not.

Rationale

This summer I attended my first TEDx Talk in Wilmington, Delaware, and I thoroughly enjoyed all of the topics; however, there was one session that left me feeling a bit unsettled, the one on fracking. In examining my feelings, it wasn't the actual topic that left me feeling this way; it was the way the information was presented. I always try to become thoroughly informed before taking a position on a topic, especially one that has the potential to trigger emotion. The speaker, while professional, used an aggressive approach towards the benefits of fracking. His arguments were sound in the sense that, yes, our sources of natural gas were dwindling and that fracking could indeed make us less reliable on foreign sources for oil and gas. It could even drive down the prices we currently pay for heating our homes. All of these were interesting points to ponder, but for me they only served to fill me with more questions about fracking.

Ultimately, my thoughts turned to my students. As a teacher, I am always trying to encourage them to think deeper and more critically. I want them to question things and make connections with their own reality, their own worlds. I chose fracking for my unit partly due to my own interest in the topic; however, I also thought it would be a good experience for my students to research and explore a topic that is controversial. I want them to understand that there are biased sources of information out there and that it takes time and a discerning eye to filter through them. I also thought fracking would be a great topic to explore with my students because I could make it a cross-curricular unit, thus tapping into a multitude of skill sets. I foresee a unit rich in science (geology, physics, the environment), English Language Arts (researching, analyzing, writing, debating), math (measurement, estimation, economics), social studies (impact on community, jobs) and art (drawing maps and drilling techniques, diagrams). Finally, my hope is that this unit will stimulate my students into thinking more about the environment, the economy, energy resources, and community and how they play a part in all of it.

I started thinking about how I would need to prepare my students for this unit. Because I am split between two schools, I feel as if I really do not get to see my students on a consistent basis. My students are not necessarily "gifted" but were put into the enrichment program because they scored well on their end of the year standardized test. They are wonderful kids and eager learners but they are not the type of students who take an idea and run with it. I need to be very careful and plan this unit specifically with their needs in mind…not mine!

Before we even get started on this unit, there are a couple of areas where I need to provide them with a stronger foundation. I am going to need to familiarize them with more graphics, diagrams and maps. While they may see and use them in their text books, the examples given are often isolated and not connected with research. It will be important to learn to interpret the various types as well as compare and contrast them with other graphics. Another concern of mine is current events. They are not exposed often to current events and the news sources that present them, especially at home. I will

need to carefully research sites that are not only acceptable to use at school, but that are not laden with biases.

On the flip side, I feel some of the topics and skills we cover during class will prepare my students for this unit. We do quite a bit of estimation and measurement during our math classes so I am excited to see how they will use these skills during our research on fracking. During the first few weeks of school we spent quite a bit of time establishing our classroom environment as one of curiosity, open mindedness and respect. My students have become very respectful of others' opinions. One of the warm ups I do with my students to promote this is called "Table Topics." It is a box of cards with questions written on each card; we go around the table and each student gets the chance to answer. Some are light and humorous but others are more serious and require

Demographics and School Background

I teach 3rd-5th grade gifted and talented students in two different k-5 elementary schools in the Christina School District in Delaware. Both of my schools are classified as Title One Schools. Oberle Elementary School has a population of almost 800 students and Jones Elementary has a population of about 500 students. The district's criteria in choosing elementary students for the gifted and talented/enrichment program are based upon standardized test scores, academic performance and teacher recommendations. Due to the fact that I am split between two schools, I see my students from Oberle on Monday-Wednesday and I see my students from Jones on Thursday and Friday. The enrichment program for both schools is considered a pull-out program and I see them for math and reading with each class meeting for about 45 minutes. While math and reading are the primary subjects I teach them, I also try to incorporate science, social studies and financial literacy into my curriculum so that I might broaden their learning experience. For this project, I will focus this unit around my 5th grade students.

The majority of my students come from low income, Hispanic and African American backgrounds. Several of them are the only English speaking members of their families; at times communication home can be problematic. Most of my students are not well traveled and do not get to see the world beyond their neighborhoods.

Fracking has the potential to be a tricky topic to present because of its many pros and cons. My students do not often have the time in their regular classes to fully explore a topic and drive their own research. Nor do they have adequate opportunities to take positions on issues and debate their viewpoints. I want to help them start considering the variety of resources available to them, recognize biased versus factual information, and be able to explain and defend their reasoning intelligently.

When I first started thinking about this unit I think I got a little ahead of myself. I was excited about the prospect of all the supporting discussions and activities we could have throughout the unit. It was not until I started discussing my ideas with my colleagues that

I discovered that several of them did not even know what fracking was. Initially, I was shocked but upon further reflection, I realized I needed to dial it back a bit and build up a basic foundation of what energy is, and what types we might use on a daily basis. I would probably lay some additional groundwork about basic geology in terms of how sedimentary rock is formed.

I envision this unit lasting about one month (or roughly 8, 45 minute classes) although I would like to factor in more time for additional research and activities, if there is interest. My hope is that by the end of this unit, they can take what they have learned and share it with their teachers and students in their regular classrooms. It would be fantastic if we can take it a step further and set up a network where my students could communicate with other students in and outside the district about their research, findings and activities. Throughout this unit I hope to serve as a facilitator and guide them "how" to think, not "what" to think. It is not my intention to tell them that fracking is good or bad. Life is not always that simple. I want them, through much research, analysis debate with one another to form their own opinion.

Essential Questions:

1) If there are still unknowns and concerns about fracking, why do you think gas companies continue to use the process?
2) Do the benefits of fracking such as employment opportunities and monetary profits outweigh environmental concerns?
3) Gas companies often give large sums of money to communities in which the companies plan to build new wells and use fracking for the initial extraction. The money can be used for schools, parks and hospitals. If you learned one of these companies was looking to drill in your area, what would you advise your family and neighbors to do: Back it, oppose it, or do a lot more research? Explain why the drilling is –-or is not—worth the advantages that all of that gas money can bring to a town.

Background Information/Content:

Natural Gas

Energy independence is a topic that dominates our energy debate in this country. Many people feel like we should look for resources within our own country to satisfy our fuel needs. For instance, in order to satisfy our natural gas demands, the process of hydraulic fracturing or fracking is being used more frequently. For the last couple of years, 25% of the energy we used came from natural gas. This percentage is likely to increase in the future.

Natural gas forms over millions of years from the decomposition of plant and animal matter that has been deeply buried and under intense pressure and heat. It is a

nonrenewable fossil fuel that is clean, odorless and very volatile. Although the burning of natural gas produces carbon dioxide, it is considered a much cleaner fossil fuel than coal and petroleum. Besides using natural gas for cooking and heating our homes, it is also used to produce steel, glass, paper, clothing, brick, electricity and as a raw material for products ranging from fertilizer to plastics to medicines.

> Although industry accounts for a great deal of natural gas consumption in the United States, industrial consumption is concentrated in a relatively small number of industries. Natural gas is consumed primarily in the pulp and paper, metals, chemicals, petroleum refining, stone, clay and glass, plastic and food processing industries. Gases such as butane, ethane, and propane may be extracted from natural gas to be used as a feedstock for such products as fertilizers and pharmaceutical products (1).

Shale Gas

Shale is a fine-grained sedimentary rock that can be rich in petroleum and natural gas. Sedimentary rocks are rocks formed by the accumulation of sediments at the Earth's surface and within bodies of water. Shale gas is found in formations with a high concentration of natural gas. One of these shale formations is virtually in our own backyard, the Marcellus Shale Formation; it covers large parts of Pennsylvania and portions of New York and West Virginia.

Shale gas is one of the most rapidly growing forms of natural gas. It, along with other non-conventional forms of natural gas such as tight gas and coalbed methane, will make a major contribution to future North American gas production. Unconventional natural gas deposits are difficult to characterize overall, but in general are often lower in resource concentration, more dispersed over large areas, and require well stimulation or some other extraction or conversion technology (2). The Barnett shale in the Fort Worth Basin, the Fayetteville shale in Arkansas and the Woodford shale in Oklahoma have all been tremendously successful and are playing a major role in natural gas production. Recent announcements of emerging extraction sites in Appalachia, Northern Louisiana, British Columbia and South Texas indicate widespread potential of shale gas resources across North America (3).

Marcellus Shale

The Marcellus Shale is center stage for the debate over the issue of fracking. The Marcellus Shale formation is named after a town in upstate New York and lies under three-quarters of Pennsylvania and parts of New York, Maryland, Ohio and West Virginia. While geologists have known about the Marcellus Shale for decades, it took the rise of natural gas prices along with the advancement of hydraulic fracturing methods to set off the fracking frenzy. In early 2008, Terry Englander, a geoscience professor at Pennsylvania State University, and Gary Lash, a geology professor at the State University

of New York at Fredonia, surprised everyone with estimates that the Marcellus might contain more than 500 trillion cubic feet of natural gas (4). Analysts may disagree over the output estimates from the Marcellus Shale, but most would agree that it is a major source of natural gas. The presence of an enormous volume of potentially recoverable gas in the eastern United States has a great economic significance (5).

> The Pennsylvania Department of Environmental Protection reports that the number of drilled wells in the Marcellus Shale has been increasing rapidly. In 2007 only 27 Marcellus Shale wells were drilled in the state, however, in 2010 the number of wells drilled had risen to 1386. Many of these wells will yield millions of cubic feet of natural gas per day in their first year. However, the yield of individual wells will most typically fall rapidly over the next few years (6).

Well Drilling and Fracking Techniques

Extracting natural gas uses vertical and horizontal drilling. A vertical shaft is drilled several hundred meters into the earth. From there a horizontal hole is driven into the layer bearing gas. Horizontal sections can range more than 5,000 feet long. Next, the fracking fluid is pumped into the ground using high performance pumps. On average the fluid consists of about 8 million liters of water, several thousand pounds of sand, and about 200,000 liters of chemicals (7). The mixture penetrates into the rock layer and produces numerous cracks; the sand prevents the cracks from closing again. What role do the chemicals play? The chemicals perform several tasks. They compress the water, dissolve minerals and kill off bacteria. The majority of the fracking fluid is pumped out again and now the natural gas can be recovered. As soon as the gas source is exhausted, the drill hole is sealed and the fracking fluid is pumped into deep underground layers and sealed there.

The Controversies of Fracking

> In 2000, shale beds provided just 1 percent of America's natural gas supply. Today, that figure stands at nearly 25 percent. With the enticing specter of energy independence in the balance, some have argued that such efforts to recover natural gas need to be expanded. Activists concerned with fracking's potential environmental hazards view the process as a serious threat (8).

Contaminating Groundwater

One controversial aspect of fracking is how the fracking waste water is disposed. When the supply of shale gas is exhausted, the fracking water is disposed into deep injection wells. These wells are for storage and buried deep underground.

> Although the total concentration of chemical additives in fracking fluid is generally less than 2 percent, millions of gallons of fluid are typically used to drill

> a well. That means that thousands of gallons of chemicals could be used that might potentially impact human health and the environment (9).

Environmentalists, experts and regulators have very opposing views of whether or not fracking contaminates water wells and groundwater. While some might support that these wells are safe, others suggest that the wells have structural issues and have allowed chemicals and waste contaminants to leak to the surface and into groundwater, and local aquifers used for drinking water. Case in point, a 2011 EPA report claims that the process of fracking does indeed cause groundwater contamination as in the case of gas drilling in Central Wyoming. ProPublica's report on the EPA's paper is here http://www.propublica.org/article/feds-link-water-contamination-to-fracking-for-first-time

However, for every case claiming fracking can cause groundwater contamination, there are countless people opposing the claim.

> Ernest Moniz, Secretary of U.S. Department of Energy: "To my knowledge, I still have not seen any evidence of fracking per se contaminating groundwater." (August 2013)
>
> U.S. Geological Survey: "This new study is important in terms of finding no significant effects on groundwater quality from shale gas development within the area of sampling." (January 2013)
>
> U.S. Govt. Accountability Office (GAO): "Regulatory officials we met with from eight states-Arkansas, Colorado, Louisiana, North Dakota, Ohio, Oklahoma, Pennsylvania, and Texas-told us that, based on state investigations, the hydraulic fracturing process has not been identified as a cause of groundwater contamination within their states." (September 2012)
>
> Dr. Stephen Holditch, Dept. of Petroleum Engineering, Texas A&M University; member of DOE's SEAB Shale Gas Production Subcommittee: "I have been working in hydraulic fracturing for 40+ years and there is absolutely no evidence hydraulic fractures can grow miles below the surface to the fresh water aquifers." (October 2011) (10)

Impeding our current water supply

An interesting point to consider about fracking is the impact it has on our current water supply. While possible contaminated underground water leads the list of concerns, other concerns include what impacts fracking has on land sites such as clear cutting, erosion, surface contamination, depletion of surface freshwater and shallow drinking water aquifers, and habitat destruction. Many areas of our country are experiencing water shortages and some environmentalists are concerned that fracking will only add to that

problem. The process of fracking uses a considerable amount of water, and some of that water will be contaminated and stored underground permanently.

> Every fracking job requires 2 million to 4 million gallons of water, according to the Groundwater Protection Council. The Environmental Protection Agency or EPA has estimated that the 35,000 oil and gas wells used for fracking consume between 70 billion and 140 billion gallons of water each year. That's about equal, EPA says, to the water use in 40 to 80 cities with populations of 50,000 people, or one to two cities with a population of 2.5 million each (11).

Some of the areas where oil and gas development are being explored also happen to be regions where water is already at a premium. Drought and overpopulation certainly contribute to communities becoming high water-stress zones, but overall we're seeing large withdrawals of water for use by agriculture, municipalities and industry like never before. With increasing water demands and conflicts over water usage continue, the topic of water should be at the forefront of discussions for corporations and policy makers.

> Prolonged drought conditions in many parts of Texas and Colorado last summer created increased competition and conflict between farmers, communities and energy developers, which is only likely to continue…Even in wetter regions of the northeast United States, dozens of water permits granted to operators had to be withdrawn last summer due to low levels in environmentally vulnerable headwater streams *(12)*.

Alternative Energy Options to Consider

While discussing the controversial characteristics of fracking, I also think it is important to talk about the other energy resources available to us in this country. Like fracking, each energy resource has pros and cons and I want my students to become complex thinkers, taking each of them into consideration. Aside from natural gas, the other energy resources include: solar energy, wind energy, hydropower, coal and biomass.

The pros of solar energy include: nonpolluting, constantly renewed, most abundant energy source available and systems last 15-30 years. The cons of solar energy include: high initial investment, dependent on sunny weather and supplemental energy needed in low sunlight areas.

The pros of wind energy include: no emissions, affordable, little disruption of ecosystems and relatively high output. The cons of wind energy include: output is proportional to wind speed, not feasible for all geographic locations, high initial investment, ongoing maintenance costs and extensive land use.

The pros of hydropower include: no emissions, reliable, capable of generating large amounts of power and output can be regulated to meet demand. The cons of hydropower include environmental impacts by changing the environment in the dam area, hydroelectric dams are expensive to build, and dams may be affected by drought and have potential for floods.

The pros of coal include: abundant supply, currently inexpensive to extract and reliable and capable of generating large amounts of power. The cons of coal include: emits major greenhouse/acid rain gases, higher environmental impact from mining and burning, and can be dangerous for miners.

The pros of biomass include: abundant supply, fewer emissions than fossil fuel sources and auto engines easily convert to run on biomass fuel. The cons of biomass include: source must be near usage to cut transportation costs, emits some pollution as gas/liquid waste, and uses some fossil fuels in conversion.

Teaching Strategies

Differentiated Instruction

I have a variety of learners in my classroom. In order to meet their diverse needs I will use Differentiated Instruction. This type of instruction addresses a variety of learning styles and needs of students while focusing on the potential of each student. I plan on offering my students a variety of resources for their research topics such as books, audio and video tapes, newspaper and magazine articles, and websites. Along with the variety of research opportunities, I will also give them choices as to how they would like to present their information. Some of these may include products such as Power Points, poetry, art, music and recorded interviews along with other examples to reflect their particular learning style.

Vocabulary Cartoon

I first got this idea from my son's SAT Prep resource and saw that it was a great way to help students visualize new words. Once my students got the hang of vocabulary cartoons, they enjoyed creating them for other subjects such as social studies and science. It includes the following components:

- vocabulary term
- phonetic spelling
- brief description
- sentence that uses the vocabulary word
- cartoon showing the word in action

Making Connections

I love using this strategy when my students are analyzing short stories, poetry and non-fiction selections. Learning becomes more meaningful when students can make personal connections to what we are learning in class. While reading and researching, students will make text-to-self connections, text-to-text connections, and text-to-world connections. When students are able to make these connections, they are better able to understand a character's personality, motives and feelings.

Graffiti Wordwall

As the students are learning new concepts and vocabulary, I will have them create word posters. It is a positive way to recognize and showcase student work into part of the classroom. I let the students typically use an 81/2 x 14 sheet of paper and let the students tape them together creating a mural. The graffiti criteria include:

- vocabulary word is drawn using bubble letters
- description of the term using own words
- at least three images depicting the term
- all white space must be colored in

Think. Pair and Share

The Think-Pair-Share strategy provides differentiated instruction by giving students a format and a designated amount of time to think about a topic, formulate ideas and share these ideas with a fellow classmate. I enjoy using this strategy in my classroom because it involves whole classroom participation in learning and gives students opportunities to share ideas with at least one other student. This is especially helpful for students who might be shy, lack confidence to share ideas in front of large groups and/or hesitant to participate. I also use this activity as an informal assessment; as I circulate around the class and listen to the various viewpoints and conversations.

In Think-Pair-Share, a problem is given and the student has a designated time (a few minutes) to think about the problem. The students then work in pairs to solve the problem. Afterwards, the pair shares their ideas/solution with the class. I have used this strategy in a variety of classroom activities such as brainstorming, Morning Meetings, topic development and quiz reviews. Think-Pair-Share helps students conceptualize an idea, sift through information, draw conclusions and consider the points of view of others.

Frayer Model

The Frayer Model is a type of graphic organizer that helps students learn and understand new vocabulary. They accomplish this by coming up with their own personal definition, provide meaningful examples and give a visual representation.

After assigning the designated vocabulary for the lesson, students are put into groups of two to four people and assigned a term. I like to walk around and ask thoughtful questions to encourage them to think through their reasoning. Students can present their Frayer Model as a group to the rest of the class or one representative from each group can circulate around to other groups. I have found a timer is useful during this activity to keep everyone on track.

The following elements are included in a Frayer Model:

- vocabulary term
- definition
- visual representation
- synonym
- sentence using the term in the proper context

Classroom Activities

Lesson Plans

This is a 12-15 day curriculum unit about hydraulic fracking and is designed for 5th grade students. The goal is to provide students with a clear understanding of what fracking is, why it is controversial and how it might impact them now and in the future. The lessons will center on independent and group research, map analysis and hands-on activities. Throughout the unit, students will be given opportunities to lead discussions and foster debates. Through role-playing, students will examine how fracking impacts various members of a community. By the end of the unit, students have thought more critically about the environment, the economy, energy resources, and community and how they play a part in all of it.

When I initially started planning this unit I went straight to fracking and designed lessons about why it is controversial. However, when I started discussing the concept of fracking with my students, I quickly discovered they had little to no prior knowledge on the subject. I revamped my initial ideas and decided to provide them with more of a foundation about involving energy sources, renewable/nonrenewable energy and supply and demand of energy. My first two activities center around these concepts:

Lesson One: Shale: A Sedimentary Rock (one to two days in length)

Objectives:

1. Define the term, “organic”.
2. Recognize how sedimentary rocks are formed.
3. Identify shale as a sedimentary rock.

Vocabulary:

Organic- characteristic of, pertaining to, or derived from living organisms.
Sediment – the matter that settles at the bottom of a liquid
Pressure – the state of being pressed or compressed
Shale – a rock formed from the consolidation of clay material

Materials:

Large clear jar with lid, sand, pebbles, small sea shells, pie pan, plant parts, Plaster of Paris, shale rock (actual rock or picture), measuring cup, resource books, laptops

Procedure A

I will have the students partner up and look up the word "sediment" using a laptop or resource book. I will explain the relationship of sediment to sedimentary rocks. To demonstrate how sedimentary rocks are formed, I will ask volunteers to put about 2 cups of small shells, sand and pebbles in a large jar, have them add about 4 cups of water, stir and shake. Students should observe and be able to describe how the materials mixed together and which materials sank to the bottom.

Procedure B

In the same jar, I will ask a volunteer to add the plant matter (about 2 ounces) and shake the jar. We will discuss how sedimentary rock is formed when plant and animal matter mix with nonliving materials. I will introduce the term, "organic" and have the students look up the meaning: matter derived from the remains of plants and/or animals.

We will then add Plaster of Paris to the jar. For best results use 1 part plaster to 5 parts sand/water/plant mixture. After mixing thoroughly, we will pour the mixture onto the pie pan, filling it about half-way.

We will set pan in a dry, warm area and allow to completely dry for several days. The solid material will harden on the bottom of the pan. I will guide the students to observe how the water evaporates leaving the sediment behind. Finally, I will explain that the matter that is sticking together demonstrates how sedimentary rocks form; however, in reality this process can take thousands to millions of years to form.

It would be ideal to have an actual specimen of shale so students can observe the fine grains. If a shale specimen is not available, use a picture.

Formative Assessment: For their exit ticket, I will have the students illustrate and describe how sedimentary rock is formed.

Lesson Two: Organic Matter and Natural Gas

Objectives:

1) Recognize that natural gas is a product of decomposing organic material.

2) Identify that natural gas is a nonrenewable energy resource.

Vocabulary:

Decomposition – the act of rotting or decaying

Pressure – the continuous force exerted on or against an object by something in contact with it.

Methane Gas – a colorless, odorless primary component of natural gas

Materials:

2 plastic soda bottles (2 liter size), sand, soil, 2 extra-large balloons, plant pieces

Procedure

I will review the term, "organic" (matter derived from plant and/or animals) with the students.

I will ask a volunteer to take one of the bottles and cover the top with a balloon. This will be considered the "control" of the experiment.

I will ask another volunteer to take the other bottle and fill the bottom 1/3 with shredded plant material. We will cover the plant material with a layer of sand and soil, and place the balloon on top of the bottle. We will then put the bottles in a sunny location for at least a week. I will have students check for any gas collection in the balloons.

I will use this experiment to show how natural gas is formed. Organic matter decomposes and is buried deep in soil or sand. Over many years of intense heat and pressure, natural gas forms.

Formative Assessment: For their exit ticket, I will ask students to use their drawings to compare the "control" bottle with the other bottle containing the plant material. They will be able to compare this experiment with how natural gas is formed.

Lesson Three: Energy Source Comparison (2-4 days)

Objectives:

1) To define and discuss the difference between renewable and nonrenewable energy resources
2) To identify and debate the environmental impacts of natural gas drilling compared to other sources of energy.

Vocabulary

Solar energy – energy derived from the sun in the form of solar radiation

Wind energy – a form of energy in which wind turbines convert the kinetic energy of wind into mechanical or electrical power that can be used for power

Hydropower – electricity generated from using the energy of moving water

Natural gas – a gaseous mixture consisting mainly of methane trapped below ground

Coal – a black or dark brown combustible mineral substance consisting of carbonized vegetable matter used as fuel.

Biomass – a biological material derived from living or recently living organisms.

Materials

Resource books, magazines, computers

Procedure

This is an interesting activity that would give the students an opportunity to further research alternative energy sources would be to create an Energy Source Comparison Chart. I will ask students to get into groups. Each group can be comprised of 3-4 students. I will assign each group an energy source: solar energy, wind energy, hydropower, natural gas, biomass and coal. The goal of each group is to research their energy resource and describe at least three pros and three cons for their energy resource. This activity would make a great foundation for a planned debate among the various energy sources and ultimately, the pros and cons of fracking.

Formative Assessment: For their exit ticket I will ask students to create an Energy Source Comparison Chart and be able to explain it. The chart could be drawn on a poster board or if computers are available, students could create their charts in the form of a PowerPoint, Glog or Prezi.

Appendix

Common Core Standards

CCSS.ELA-Literacy.RI.5.3
Explain the relationships or interactions between two or more individuals, events, ideas, or concepts in a historical, scientific, or technical text based on specific information in the text.

CCSS.ELA-Literacy.RI.5.5
Compare and contrast the overall structure (e.g., chronology, comparison, cause/effect, problem/solution) of events, ideas, concepts, or information in two or more texts.

CCSS.ELA-Literacy.RI.5.6
Analyze multiple accounts of the same event or topic, noting important similarities and differences in the point of view they represent.

CCSS.ELA-Literacy.RI.5.9
Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably.

CCSS.ELA-Literacy.SL.5.1
Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on *grade 5 topics and texts*, building on others' ideas and expressing their own clearly.

CCSS.ELA-Literacy.W.5.1
Write opinion pieces on topics or texts, supporting a point of view with reasons and information.

CCSS.Math.Content.5.MD.B.2
Make a line plot to display a data set of measurements in fractions of a unit (1/2, 1/4, 1/8). Use operations on fractions for this grade to solve problems involving information presented in line plots.

Video Links

http://education.nationalgeographic.com/education/media/how-hydraulic-fracturing-works/?ar_a=1

https://www.youtube.com/watch?v=Uti2niW2BRA

http://www.dangersoffracking.com/

Resources: Annotated Bibliography

"Is Fracking a Good Idea?" US News. Accessed November 17, 2014. http://www.usnews.com/. Great article to consider how to debate fracking.

"Facts About Shale Gas." American Petroleum Institute. Accessed September 10, 2014. http://www.api.org/. This article about shale gas is helpful to both students and teachers alike to build background content.

King, Hobart. "Marcellus Shale-Appalachian Basin Natural Gas Play." Geology.com: News and Information for Geology & Earth Science. Accessed October 2, 2014. http://geology.com/. Thoroughly written about the fracking procedures.

"Uses in Industry." NaturalGas.org - Brought to You by NGSA. September 20, 2013. Accessed August 28, 2014. http://naturalgas.org/. Insightful article to use with Lesson 2.

"Marcellus Shale: Natural Gas Energy." EFMR Monitoring Group. Accessed November 4, 2014. http://www.efmr.org/. This article is useful in building critical thinking skills.

Mooney, Chris. "Why Coal Is (Still) Worse Than Fracking and Cow Burps." Mother Jones. August 29, 2014. Accessed September 15, 2014. http://www.motherjones.com/. This article is a nice complement to this unit because it provides additional perspectives.

"Energy Source Comparison." Energy4me Energy Source Comparison Comments. Accessed November 4, 2014. http://www.energy4me.org/energy-facts/. Website that deals with organizing and interpreting data of energy resources.

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Curriculum Unit Title	Hydraulic Fracturing Our Nation	Author	Suzanne Cline

KEY LEARNING, ENDURING UNDERSTANDING, ETC.

Gaining in-depth knowledge about natural resources and understanding the supply and demand of these resources on a local, national and global scale.

ESSENTIAL QUESTION(S) for the UNIT

1. If there are still unknowns and concerns about fracking, why do you think gas companies continue to use the process?
2. Do the benefits of fracking such as employment opportunities and monetary profits outweigh environmental concerns?

CONCEPT A	CONCEPT B	CONCEPT C
Sedimentary Rocks	Organic Matter and Natural Gas	Energy Source Comparison
ESSENTIAL QUESTIONS A	**ESSENTIAL QUESTIONS B**	**ESSENTIAL QUESTIONS C**
What is shale? How is it formed?	What type of resource is natural gas? How is it formed?	What are the advantages and disadvantages of wind energy, solar energy, hydro power, natural gas and coal as energy resources?
VOCABULARY A	**VOCABULARY A**	**VOCABULARY A**
Organic, Sediment, Shale	Decomposition, Pressure, Methane Gas	Hydroelectric power, wind energy, solar energy, natural gas, coal

ADDITIONAL INFORMATION/MATERIAL/TEXT/FILM/RESOURCES