Classrooms and Communities in Cooperation with Corporations and Government: Natural Gas and Creative Conflict Resolution

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Overview:

This curriculum unit will enable students to make connections between the "content area learning in classrooms and applications of content area learning in the real world" hence it may be used as a standards aligned Service Learning project for sixth to eighth grade middle school students. Teachers implementing this curriculum unit have an option of completing activities/lessons from this unit in cooperation with teachers from content areas such as Reading, English, and Language Arts (RELA), Social Studies, and of course, Science. On the other hand, a sixth grade teacher in a self-contained classroom may prefer to facilitate the lessons independently. However, this unit is conducive to the spirit of collaboration in that the activities/lessons draw on the diversity and expertise of teachers as well as students with strengths and experiences in various disciplines.

However, an important component of this unit is its suitability for inclusive as well as supplemental support levels of special education classes in that the lessons/activities are differentiated relative to content, process, and product. Therefore, teachers can modify, adapt, enrich, or extend *content* of lessons based on the readiness levels, strengths, and needs of students in their classes. In terms of *process*, the teachers and students can determine the most effective ways for individual students to learn the content based on data about student multiple intelligences, preferences, and talents. Furthermore, students and teachers have the opportunity to choose the types of evidence or *products* of learning students will present to peers, the school staff, and the neighborhood community. Most importantly, the activities from the unit are accomplished as teachers adhere to our twenty-first century mandate to "incorporate technology as both a tool for research and acquisition of information" as well as a tool for students to produce and present evidence of their learning in the home, school, and community.

In sum, this unit is an environmental science themed project-centered learning experience that incorporates reading, writing, math, and social studies content in the context of a real-world contemporary issue. In an era of mandated inclusion, it is imperative for educators to have opportunities to plan in collaboration and differentiate instruction to meet the needs of *every* student in the context of inclusive and/or self-contained classrooms to the fullest extent possible. It is pertinent to note that students *with or without documented disabilities* may accomplish the activities presented in this unit. For example, *all* students need to demonstrate understanding of principles taught in RELA classes such as summarizing, analyzing, and evaluating, among other objectives such as making inferences and reading critically in content areas. Therefore, teachers will note that the suggested activities easily lend themselves to being accomplished in collaboration with teachers from disciplines such as language arts, science, social studies, and/or computer technology.

Since my students receive literacy and math interventions for a portion of the day in the autistic support classroom and participate in science and social studies content inside of inclusive co-taught classrooms with appropriate academic supports and services for another portion of the day, I can implement this unit in cooperation with the science and social studies teachers as a Service Learning project. In addition, the *activation of prior knowledge* segment and building of background knowledge/interest portion of the unit is aptly facilitated through Community Based Instruction which is a component of the specially designed instruction program for students with autism spectrum disorders.

Rationale:

INFLUENCING A PARADIGM SHIFT: RESEARCH BASED APPROACH

"Science is more than a body of facts, a collection of principles, and a set of tools for measurement. Science is a structured and directed way of asking and answering questions. It is a pedagogical triumph to teach students the facts of science and technology; it is a pedagogical triumph to teach students these facts in their relation to the procedures of scientific inquiry" (Ostlund, 1992). This statement affirms the objective of this unit which is for students to embrace an issue, develop knowledge of it through scientific inquiry, and connect this issue to personal experiences, political choices, and/or career skills. This objective is further supported by the following excerpt from an article in the March 2010 edition of Educational Leadership titled "Making Science Real" which states: "Students should learn fundamental science concepts - also called *big ideas* - in the context of doing science, while learning about what science is and how it works. The good news about science instruction is that all major reform documents in science education deemphasize memorizing vocabulary and relying on textbooks" (Olson & Mokhatari, 2010). This unit not only teaches students to embrace the role of scientist as a lab practitioner but also as a member of an inter-connected global community.

It is crucial for students to make relevant content connections to their lives through continuous exposure to science in the home, school, and in the local community. Students can gain an appreciation for and a connection to the environment through ongoing field trips or visits to Bartram Gardens, Heinz Conservatory, and the Museum of Natural Sciences. Other ways teachers can facilitate an awareness of energy issues, nature, and science is through allowing students to care for plants in classrooms, offering opportunities to reduce, reuse, and recycle in school and home communities, and exposing students to hands-on science through the curriculum/lessons offered by staff at places such as Bartram Gardens. Also, it is essential for students to have access to books and magazines via the classroom library that highlight or discuss components of earth and environmental science. *These suggestions are viable and serve as alternatives for teachers with classes that do not engage in Community Based Learning experiences.* Ultimately, the lessons are designed to encourage teachers and students alike to 1) incorporate technology 2) engage in collaboration and 3) support learning in the context of differentiation. The affective learning outcomes are for each student to understand their role as community stakeholders in the context of researching and designing a community awareness campaign relative to an environmental science issue.

Background:

The focus of this unit is derived from the topic of extraction of natural gas from the Marcellus Shale specifically as this topic relates to our neighboring region of Western Pennsylvania. As I offer some background information relative to this topic, I aim to present readers with multiple perspectives of this issue.

Emergence of Hydraulic Fracturing in the Marcellus Shale Region

The process of drilling for and extracting natural gas, commonly referred to as horizontal drilling and hydraulic fracturing (fracking), is technically defined as:

> …the process of creating fissures, or fractures, in underground formations to allow natural gas to flow. Variables such as surrounding rock formations and thickness of the targeted shale formation are studied by scientists before hydraulic fracturing is conducted. By using new drilling and hydraulic fracturing techniques, extensive deposits of natural gas are being found in underground shale beds in the eastern and southern U.S., apparently enough to supply the country for many years. One of the finds is in the Marcellus Shale Formation which extends through Pennsylvania, New York, Ohio and West Virginiam, close to major markets and pipelines.
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> (Langston, 2010)

It is important to note that the Marcellus Shale, as a formation in the earth, has had the deposits of natural gas for a long time. Nevertheless, "the Marcellus Shale, a black shale formation that lies up to 10,000 feet below ground surface extending over 54,000 square miles primarily in New York and Pennsylvania, contains between 168 trillion to 516 trillion cubic feet of natural gas. There are trillions of cubic feet of recoverable natural

gas in the Marcellus shale, for example, more than enough for the next 45 years" (Finkel, 2011).

As we lead our students into making meaningful connections about the role of technology in science, it is important then to emphasize that it is the development of the technology that has given humankind access to the natural gas. This connection is supported by the following statement which maintains: "The natural gas industry has been aware of the ability of the Marcellus Shale to store natural gas but has found it difficult using traditional (vertical) drilling techniques to find and reach the fractures in the shale that trap the gas. The researchers believe that horizontal drilling, though more expensive than vertical drilling, can encounter a large series of these fractures sequentially, thus exposing multiple pockets of gas" (Pennsylvania State University, 2008). It is also important for students to understand that the new technology of horizontal drilling has made extraction of the gas a financially attractive option to the business community. The process and financial viability of extracting natural gas from shale deposits may be summarized as follows: "Two technological advances made shale gas economically feasible to produce: horizontal drilling and hydraulic fracturing (or fracking). To extract the gas, workers must drill down until they hit a thin layer of shale, 1,000 to 12,000 feet underground, and then steer the drilling horizontally for several thousand more feet. Fracking fluid - water, sand, and chemical additives - is injected into the layer at high pressure, perforating the formation and. opening tiny cracks in the shale, thus allowing the trapped gas to escape" (Deutch, 2011). The effects and influences of technology as noted are not stand-alone concepts but rather ones that are influenced by other factors such as financial and political considerations.

As educators presenting this unit to our students, it is imperative for us to share the inter-curricular connection between scientific developments and the status of our nation socially, politically, and financially. Moreover, these factors influence our decision of whether or not to develop or use these technologies in the first place. If a technology is cost-efficient as well as capable of solving a problem or meeting a need, it will most likely be utilized by our culture. If it is capable of solving a problem or meeting a need but cannot be accomplished in a cost-effective manner, it will most likely not be utilized. This is best seen in the case of how businesses embarked on drilling endeavors in the Marcellus Shale region with the advent of the cost-effective horizontal drilling technique. It is wise for our emerging scientists to have a concept of how decisions made by members of business communities can hinder and/or advance scientific progress.

WATER

There are health and environmental concerns relative to how water is used in order to initiate and sustain the process as well as the impact of engaging in hydraulic fracturing (fracking) as it relates to the water supply. The issues causing concern are: the movement of gas or fracture fluids; amount of water used; the management of contaminated water; control of surface spills; and the disclosure of chemical additives, some of which are toxic. The movement, or migration of fluids relates to the opportunity for gas or fracture

fluids to travel to undesired locations such as water wells of property owners, farm land, or water reservoirs, whereas water use relates to the extensive amounts of freshwater required to complete the extraction process.

Our students need to understand there is a large issue and public debate about how (or if) drilling companies are engaging in responsible disposal or recycling of fluids. Further, there is additional concern about corporate management and government oversight of "accidental" spills of fracking fluids. The final listed concern centers on the lack of public awareness regarding the chemical additives used for the fracking fluids. The evidence that "fracking" businesses have gained "favor" with members of the government community and have experienced exemptions from provisions of the Safe Drinking Water Act of 1972 further compounds these concerns. This Act was originally created with the intent to keep the public both protected and informed about the use and disposal of water by businesses. A review of the literature reveals:

> In the process, a mix of sand, water and chemicals is pumped deep underground at ferocious pressure. That breaks up shale formations, releasing the gas trapped inside so it can be pumped to the surface. But fracking is almost entirely unregulated, because of a 2005 statutory exemption from the Safe Drinking Water Act. Three members of Congress released a report on fracking, saying that oil and gas companies used more than 2,500 fracking products containing 750 chemicals between 2005 and 2009. Some ingredients were benign, such as citric acid and instant coffee. Others, though, were extremely toxic, such as benzene and lead. Only five states require public disclosure of the chemicals used, and only to limited and varying degrees.
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> (*Economist*, 2011)

However, a contention of this paper is not to emphasize the types or amounts of chemicals, the quantities of water used, or the significant health effects on humankind-documented and suspected. This is worthy of note but extensive research and publicity has been afforded this topic. *Rather, the purpose is intended to lead teachers into the process of guiding students into the possibilities and benefits of seeking more efficient and non-wasteful means of science* application. All too often the popular or mass media focuses on the problem but very little attention is given to the solutions that are available when humankind "digs a little deeper" (no pun intended) and invests additional time beyond our initial satisfactory (but not always perfunctory) goals. In other words, for every "fracking" problem, there are proving to be "fracking" solutions.

Moreover, admission by scientists, businesses, and government of flaws or errors in production or decision making processes generates productivity and solutions as well. There are new businesses opening up as well as new jobs being created as a result of the shortcomings of the aforementioned water related concerns. For example, "Clean Harbors cut its teeth in hazardous and industrial waste cleanup and management. Over the past several years, it expanded rapidly into oil and gas field services and cleanup" (Norm, 2011). This is just one of several available examples of how members in a business community can use scientific advancements to solve problems as well as prosper in business growth and development.

EFFECTS ON WILDLIFE AND HABITAT

A substantial portion of media attention is focused on the impact of fracking on drinking water and the water supply; yet, there are sources and grass roots organizations such as the local chapters of the Sierra Club that are addressing the impact of fracking on wildlife and forest habitats. "Drill rigs tower over the silos on farms in Pennsylvania. Once-empty… in western Colorado, where mule deer and sage grouse ranged freely, now look like a neural network from a bird's-eye view, with well-pads connected by dirt roads scattered across the landscape" (*Economist*, 2011). Teachers will note that one of the lessons allows students to consider the visual differences of how land appears "before, during, and after" fracking in the context of conducting internet research.

Other concerns are relative to "habitat earth" as noted when an article appearing in the Wall Street Journal called earthquakes "the natural gas industry's big fracking problem. In New York State, thousands of gas wells are being planned for both urban and rural areas. 'They're drilling all over Buffalo,' says activist Pat Carson, 'and there's been a steady increase in local quakes in western New York since drilling began in this area. Lawyer Rachel Treichler claims: 'We've had two earthquakes in upstate New York that are associated with disposal wells. No community is a proper site for a deep injection well disposing of toxic fluids.' In Texas, Oklahoma, Arkansas and West Virginia over the past two years, almost 1,000 small-to-medium-sized earthquakes are being investigated as 'induced earthquakes' caused by nearby fracking and wastewater disposal wells" (Nelson, 2011). Again, although the possibilities of drilling causing earthquakes are not as widely publicized in the mass media, it stands to reason that students will learn to venture into uncovering other resources that investigate these and other often overlooked factors.

TEACHING STUDENTS TO SEEK ALTERNATIVE METHODS

One aim of this unit is to encourage students to prepare for roles as proactive community members by digging deeper to uncover the existing improvements to currently used technologies which are often overlooked for a myriad of reasons. For example, another review of the literature notes:

> Instead of pumping millions of gallons of water and fracturing fluid into the earth, the company GasFrac used a liquefied petroleum gas gel -- propane gas compressed into a thick fluid -- to break up the rock. Liquefied petroleum gas (LPG) has a number of advantages over the chemical-laced water typically used as a fracking fluid. Although it is pumped into the well as a gelled liquid, it converts back into gas while underground. It can then be sucked back out as the natural gas is extracted from the reservoir, meaning that there is a virtually complete recovery of the fracking fluid; water-based methods have roughly a 50 percent recovery rate. This approach also eliminates the need for freshwater tanks or pits for waste and bypasses many of the concerns about tainting groundwater.
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> (Marsa, 2011)

It should be noted by teachers and students alike that the "reduce, reuse, recycle" movement is an important component of the fracking industry in terms of the movement's connection with wastewater commonly referred to as flow back. For example, "Tighter state regulations on waste-water treatment have helped shift the Marcellus Shale gas drilling industry dramatically toward recycling and re-using flow back rather than sending it to municipal sewage plants" (Stuhldreher, 2011). One example of developing new technologies is relative to "a field testing for a procedure called Osorb announced by the U.S. National Energy Technology Laboratory which can remove toxic chemicals from the water generated during hydraulic fracturing at natural gas wells. The Energy Department laboratory states that the new product engineered by ABS Materials eliminates water impurities using swelling glass or silica" (Hobson, 2011). Other science teams are engaged in the process of research and development to unearth viable solutions. "Texas A&M University and Terra Tek are also leading an investigation of the causes of down hole losses of frac fluid and losses of fracture conductivity. Additionally, as part of the most recent RPSEA program year, the Gas Technology Institute and the University of Texas are among the investigators of a project to develop water management methods aimed at reducing the shale plays' demand for freshwater and the environmental impact of brine disposal" (Redden, 2009).

In spite of the previously mentioned deregulation from the federal government regarding exemptions from the Safe Drinking Water Act, state governments have authority to regulate on behalf of the safety and protection of its citizens and this could be a reason for the response of research and development teams as a result of public response to an undesirable situation. Moreover, it is refreshing to know these technologies exist and that there are creative people pursuing them. When communities voice their concerns to elected and appointed officials, the business community is impacted as well. A reaction to this impact is seen in the response by businesses to create technology or resources to solve these problems.

Nevertheless, there are scenarios where businesses appear not to embark on using innovations that effectively solve challenges. Rather than criticize companies for negligence in not pursuing these alternative technologies in spite of their existing benefits, as teachers we can remind our students that often research and development efforts or even discoveries don't keep pace with the "right now" needs of businesses. Moreover, we must examine other possible reasons businesses fail to change their existing ways of doing things in the face of more sensible ones. These reasons can a include partnerships and alliances between business and scientific communities. In other words, the research efforts of scientists can sometimes be supported by businesses. A science team receiving financial and other support from a business may be less inclined to highlight shortcomings or failures of those businesses publically.

THE IMPACT OF VIABLE TECHNOLOGIES ON REGIONAL, NATIONAL, AND GLOBAL AFFAIRS

Our nation's energy crisis becomes less of a crisis as our access and availability of energy choices increase. Our choices increase as more types of energy become available. To be more concise, more energy is available as scientists create the technology to access the energy and make it available. In other words, technology makes these choices more accessible to the community. Students should understand the image of lone scientists isolated in labs is obsolete and understand the connectedness between scientists, businesses, and everyday citizens as significant role players in the "energy choice" community. An excerpt emphasizes an insight in macroeconomics and again highlights the impact scientific innovation can have on society. "Little more than a decade ago, the United States was running so low on natural gas that companies were making plans to cover the shortfall with imports of liquefied natural gas. Today, though, the marine terminals built to dock huge LNG ships in Texas, Louisiana and Maryland are being converted to ship gas out, not just bring it in" (*USA Today*, 2011).

In lieu of our nation's propensity to rely on foreign energy resources as well as the imbalance in U.S. imports versus exports, the following projection allows one to infer why American businesses as well as government officials find the extraction of natural gas a palatable option: "…the International Energy Agency (IEA) envisions a scenario under which worldwide consumption of natural gas could rise in excess of 50% by 2035 and represent over 25% of global energy use. Demand from China alone could equal that of the entire European Union. Gas production has increased substantially in the U.S. due to the use of hydraulic fracturing to extract gas from shale" (Chazan, 2011).

DIGGING DEEPER IN RESEARCH: IS NATURAL GAS REALLY A CLEANER AND GREENER CHOICE?

According to the advertisements from natural gas companies, government propaganda, and even some scientific reports this is true to a certain extent; however, as educators we want our budding scientists to apply discernment to identify factual data, propaganda, bias, and "generalizations" *especially as they are relative to claims about the effects of energy choices on the environment they will inherit one day*. One of these areas where discernment is required is the notion put forth by scientists and media alike, that natural gas is a clean burning element and therefore an environmentally friendly choice. Although there is an element of truth to this, a closer examination of a study conducted by a Cornell University Research team notes:

> We evaluate the greenhouse gas footprint of natural gas obtained by high-volume hydraulic fracturing from shale formations, focusing on methane emissions. Natural gas is composed largely of methane and 3.6% to 7.9% of the methane from shale-gas production escapes to the atmosphere in venting and leaks over the lifetime of a well. These methane emissions are at least 30% more than and perhaps more than twice as great as those from conventional gas. The higher emissions from shale gas occur at the time wells are hydraulically fractured-as

> methane escapes from flow-back return fluids-and during drill out following the fracturing. Methane is a powerful greenhouse gas, with a global warming potential that is far greater than that of carbon dioxide, particularly over the time horizon of the first few decades emission. Methane contributes substantially to the greenhouse gas footprint of shale gas on shorter time scales, dominating it on a 20-year time horizon. The footprint for shale gas is greater than that for conventional gas or oil when viewed on any time horizon, but particularly so over 20 years. Compared to coal, the footprint of shale gas is at least 20% greater and perhaps more than twice as great on the 20-year horizon and is comparable when compared over 100 years.
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> (Howarth, Santoro & Ingraffea, 2011)

Not only do we need to teach our students to avoid accepting industry propagated information at face value, but we can teach them how sometimes research and development insights are kept hidden from business promotional efforts because they are not always in the immediate financial interests of businesses.

Again, this data signals to us that it is crucial to not just accept the latest and the greatest answer to a need, problem or crisis upon face value or upon information put forth by entities such as scientists supported by businesses, business supported by governments, or even business supported by citizens in the form of company shareholders. Students need to understand that although research can be made to say what we want it to say, there are balanced ways to present the positive and negative aspects of research results as it is available through emerging technologies and/or resources. Yet, the next section demonstrates how technology can serve as a means to keep communities informed and offer businesses opportunities to display transparency in their operations for the good of the public.

USING TECHNOLOGY AS A TOOL TO INFORM COMMUNITIES AND MAINTAIN TRANSPRENCY

Another goal of the unit is to present students with access to twenty-first century modes of expression- computer based technology. Students need to understand how skills such as accessing websites, membership in blogging communities, and internet based video clips can be used to keep them informed politically, financially, and scientifically. More so, these tools allow them to become interconnected globally, regionally, and locally. As we empower our students to use technology to access information at the global level, we also prepare them to become participants in the global process. *As our students view themselves as able to access global information, they will view themselves as having a voice as well as a choice in our ever-increasing global yet diverse society.*

One such resource is as follows: The Frac Focus website features an easy-to-use interface that gives the public and regulators access to comprehensive information about hydraulically fractured wells nationwide. The website also contains information about the process of hydraulic fracturing, groundwater protection, chemical use, state regulations, publications, and links to federal agencies, technical resources and each participating

company. Within its first months of operation 40 companies had agreed to participate in the effort, more than 450 wells were loaded into the system by 18 of these companies, and the website was visited more than 28,000 times by people in 78 countries" (Fitch, 2011). It stands to reason that students in our classes with an interest in checking sports statistics or other figures may especially enjoy the opportunity to regularly check developments and data relative to well development and other components.

LIFE IS LIKE A CLASSROOM – PROCEDURES, RULES OF ENGAGEMENT, AND CONSEQUENCES AND REWARDS-EXTRINSIC AND INTRINSIC

It is relevant for educators to remind our students that the rules and procedures that govern classroom, home, and community life are transferrable to how we participate in our adult lives in terms of making ethical and moral considerations in our decision making processes. As future community stakeholders, it is crucial for students to not only learn isolated portions of content but also how the content they learn will impact their decision making in related areas of life. The following excerpt summarizes the need for educators to prepare youngsters for their role as stakeholders and decision makers. "The nation badly needs shale gas and oil, but getting it requires that drillers and regulators find a way to enforce best practices that minimize the impact on property owners and the environment. Industry, environmentalists and regulators would do well to expand efforts to devise a model set of fracking regulations that states could adopt. Drilling will never been entirely safe, clean or quiet, but it can and should be safer, cleaner and quieter. The alternative is a justifiable backlash that would make it difficult for the nation to take advantage of a crucial new resource" (*USA Today*, 2011).

In other words, the writer asserts that although we will not reach perfection in our quests for viable and safe ways of meeting our energy needs, we can indeed practice principles such as compromise, team work, and transparency as we work collaboratively to establish a set of guidelines, procedures, and consequences as a "hydraulic fracturing community." Our students need to see the link between inappropriate conduct in the business community, its' impact on the environment, and the government's response. Moreover, the students need to understand the relevance of communication skills and exercising those skills in addition to their specialty skills relative to business or science. An excerpt highlights the need for transparency and open communication. "Some industry executives agree. We've traditionally flown under the radar, and the industry is dominated by scientists and technical experts, with little if any emphasis on working with the public," said Matt Pitzarella, director of corporate communications at Range Resources, a natural-gas producer that operates in Pennsylvania. "As the industry has moved into parts of the country that haven't experienced natural-gas development in generations, we were slow to embrace a 'customer-service' approach" (Harder, 2011).

Amazingly, the same work ethics we command for our students to exhibit in classroom life are the same ones that will allow them to thrive as future scientists and businesspersons in their chosen career paths. Given a set of clear pre- determined expectations, we expect our students to do their best as citizens of a community. Allowing our students to understand the connection between corporate and scientifically

responsible behavior will give them a sense of how major issues can be resolved though the implementation of the same values we expect them to use in the classroom - best efforts in performance combined with study and practice. “For all the attention given to technologies like horizontal drilling and hydraulic fracturing, some of the greatest gains to be made in reducing the environmental risks of natural-gas production come from simple things like the proper pouring of cement well casings and the proper handling of chemicals and wastewater, so that they do not spill or seep into streams or water supplies. Avoiding spills is not rocket science. Properly constructing and operating wells is a highly technical enterprise, but most natural-gas producers know how to do it. Too many are simply failing to achieve consistently good performance” (Brownstein, 2011).

Regarding the issue of collaboration, as educators, we hope to build well rounded students with strong communication skills. These well rounded students may become scientists with the ability to effectively serve at local town meeting as well as a state senate hearing. Moreover, they will be well prepared to serve with integrity and speak with clarity when presenting pros and cons of issues as well as when engaging in the problem solving process. “Science education is not just about training the next generation of scientists – it’s also about developing responsible citizens…Students should Be able to understand political, economic, and legal issues. Someone who can do this is scientifically literate’ (Trefil & Trefil, 2009).

Then there are issues of creating sound regulations to guide the industry. Despite pressing interests and potential opportunities to create emeployment and other income opprtunities for owners of land with shale deposits, there are some states that are hesitant to engage in drilling before a conducting careful review of the facts related to fracking. “Fortunately, Maryland is taking the time to ensure drilling occurs only after proper safeguards are in place. Given that our drinking water and other natural resources are at risk, and given Pennsylvania’s checkered experience with frocking, we applaud the Governor for his leadership on this issue. Maryland has the opportunity to get it right,” said Kim Coble, Maryland director of the Chesapeake Bay Foundation, in a statement. In Pennsylvania, which has a large swath of the Marcellus Shale, Gov. Tom Corbett in March created a 30-member commission also tasked with balancing the economic potential with environmental concerns” (Mook, 2011). Maryland’s leadership sets an example for others as it carefully considers options. On a federal level, “President Barack Obama enthusiastically backs gas drilling, Along with wind, solar, and nuclear power, natural gas is crucial to Obama's goal of producing 80 percent of electricity from clean energy sources by 2035. But the drilling is taking place with minimal oversight from the U.S. Environmental Protection Agency. State and regional authorities are trying to write their own rules—and having trouble keeping up” (Efstathiou, & Chipman, 2011).

As in any classroom along with rules and procedures, there are predetermined consequences for not following the rules and regulations. Teachers can lead students into discussions relative to how corporations are not exempt from these consequences. Yet, I contend an emphasis on the purpose of the fines is important in light of the fact that mistakes and accidents are a part of life. “Chesapeake Energy, one of the most active companies in Pennsylvania's natural gas drilling boom, has been fined more than $1 million by the state, including a $900,000 penalty for contaminating private water

supplies with methane in Bradford County. Officials called it the single largest state fine ever for an oil or gas operator in the state. Pennsylvania's Department of Environmental Protection said Tuesday that it had also fined Chesapeake $188,000 for a tank fire in February in Washington County. Drillers' use of chemicals and high-volume hydraulic fracturing has stirred wide fears of river and groundwater pollution" (Associated Press, 2011).

I contend that money derived from fines can be used to restore land as well as clean up any damages. Most important, companies can be encouraged to be proactive by seeking to utilize some of the safer and clear alternatives discussed earlier in this paper. Although at first glance fair or noble, I contend that the fines be less punitive but restorative in intent. As the reader will get a glimpse of effects on wildlife and habitat aside from more exposed dangers such as impact on humans' health, natural gas company fines could be channeled to road repairs, forest rebuilding, and equipment removal when the venture is completed. Students could engage in an advance independent homework study to find out what happens to land when miners or other venture capitalists leave after their venture is completed.

COLLABORATION, COMPROMISE, AND COOPERATION CAN MAKE A DIFFERENCE

Part of the paradigm shift we hope to influence is teaching our students and budding young scientists that cooperation and collaboration are effective problem-solving tools in the classroom as well as in everyday life. We hope our students understand that their willingness to tackle difficult open-ended questions is a worthwhile endeavor although there are rarely easy answers. In our role as facilitators of learning, we can point our students to examples in history as well as contemporary times when community based intervention in the opposition to a political based decision has lead to changes in policy or other outcomes.

The following is an excerpt regarding how action amongst members of a community has led to the rescinding of a policy that would prohibit Department of Environmental Protection agents from exercising autonomy in doing a major part of what they were hired to do--- issue notices of violation. This excerpt states: "Forty-two faith, conservation and environmental organizations and businesses today sent Governor Corbett a letter asking him to order Department of Environmental Protection (DEP) Secretary Michael Kramer to rescind its new 30-day pilot policy that prevents Marcellus shale drilling inspectors from issuing notices of violations until they get approval from the secretary himself" (http://www.pennfuture 2011). The results of this community based action garnered successful results. As a result of community collaboration, the results are as follows: "Michael Krancer, secretary of Pennsylvania's Department of Environmental Protection (DEP), has tried (unsuccessfully) to defend a directive to make DEP field inspectors clear all drilling violation citations through Harrisburg first by saying that wasn't really what he meant. Krancer and the DEP lost the publicity battle and have now reversed the policy" (http://marcellusdrilling.com, 2011).

A grass roots/community alliance can get results as does research and development. The following excerpt highlights how attention from grass roots organizations can influence government and corporations in the fracking community to address public concerns. Jeff Schmidt, Director of Sierra Club Pennsylvania Chapter said, "We're calling on the Governor to cancel this pilot policy and take the handcuffs off of our environmental cops. We need prompt action to stop polluters, not bureaucratic delay" (Citizens for PA's Future, 2011).

As future voters and potential policy makers, our students need opportunities to associate current events as examples of where community action led to "desired change." Another connection made in the lessons is an across the curriculum example of how boycotting has been used to influence policy. Throughout the student conducted research using the American Natural Gas Alliance website (ANGA) and other industry promotional sites, students will notice how these entities encourage citizens to convert to natural gas. Students can understand that one way to get business and/or government to listen to their concerns is to utilize the tool of "boycotting". For example, if citizens are not patronizing natural gas suppliers for their heating and other needs because they vehemently oppose industry standards or practices, then natural gas suppliers and related entities will fail to be successful in their business. If they attribute their lack of success in business to public reaction, they are more apt to address areas in need of improvement or change in their businesses.

Students also learn how grass roots organizations can influence or lead decision-making amongst corporate shareholders. "As debate about the environmental impacts of natural-gas drilling continues to swell, U.S. energy companies will be deciding this week whether to disclose more about the possible risks to shareholders. On Wednesday, shareholders at three gas producers, including Exxon Mobil Corp. and Chevron Corp. will vote on whether the companies should provide more information about the risk of air and water pollution, lawsuits and possible harm to their reputations from an increasingly widespread drilling practice. "There's more and more evidence of environmental impacts. There's more regulatory concern. There's more reputational risk for companies," said Michael Passoff, a strategist with one of the resolutions' backers, As You Sow, a nonprofit group that pushes companies to be more environmentally friendly. The group says it isn't opposed to gas drilling" (Citizens for PA's Future, 2011). Again, grassroots involvement can impact the types of decisions companies make.

FINAL CONSIDERATIONS: INFLUENCE OF NATURAL GAS ON TRANSFORMING THE FUTURE OF VEHICLES AND TRANSPORTATION

Aside from the more widely publicized uses of natural gas in homes and businesses, there is an existing and developing market for natural gas in the automobile industry. Possible reasons for the lack of widespread advertisements on televised media is centered on the unavailability of natural gas filling stations and public uncertainty of whether they will be able to fill up their cars as needed if they are driving vehicles operating off of natural gas.

> Without question, natural gas will allow our country to transition our transportation system away from expensive and carbon-heavy gasoline and diesel towards carbon-light, affordable American produced natural gas, says Aubrey K. McClendon, CEO of Chesapeake Energy…the industry currently targets high-use urban fleet vehicles: Light, medium, heavy-duty trucks that deliver goods, taxis, courier services, shuttles. Natural gas is very attractive to companies that use heavy mileage trucks, averaging 30,000 miles a year...Most of the world's natural gas vehicles are bi-fuel; the engine is a standard gasoline internal- combustion one that runs on either gasoline or CNG from a separate cylinder in the trunk. The driver simply flips a switch on the dashboard.
>
> (Reuteman, 2011)

In conclusion, students can develop an understanding of how energy may be used to meet different types of transportation needs.

CONCLUSIONS:

During the course of this background research component, I have only highlighted a few of the issues relative to natural gas extraction and related issues. In doing so, I have hoped to offer teachers insight into how they can lead students as they complete research about the issues. Teachers can remind students that there are rarely any "yes or no" answers to challenges but rather there are ways to problem solve collaboratively, creatively, and most important, respectfully. Additionally, as students are guided in their quests to find out information, they will understand how the technology in their lives can be used to expand their community base from local to global. Finally, students will learn how to apply decisions personally as they become more environmentally conscious and politically aware.

Strategies:

This unit is interdisciplinary in that students and teachers in the role of "researchers from two or more disciplines pool their approaches and modify them so that they are better suited to the problem at hand, including the case of the team-taught course where students are required to understand a given subject in terms of multiple traditional disciplines" (www.wikipedia.org/wiki/Interdisciplinarity, n.d). On the other hand, it is multidisciplinary because "English, mathematics, science, social studies, and career technical teachers all collaborate to plan and present lessons that center around a central, career– theme, issue or problem" (http://www.connectedcalifornia.org/). This is relevant in that as twenty-first century educators we are encouraged to not only collaborate but present our students with the challenge to address authentic challenges using the technology of contemporary times.

Furthermore, this unit aligns with the School District of Philadelphia Core Curriculum requirements for science Service Learning projects and each objective allows students to apply research-based learning as they exercise the skills relative to content portions of literacy classes such as analyzing text, writing for a purpose, and making

inferences. The issue-based learning allows students to be participants in events outside of the classroom and make relevant connections to their lives through continuous exposure to science in the home, school, and community. The use of field visits is suggested to support affective learning goals and assist students as they gain an empathy and connection to the environment through their participation in events at Bartram Gardens, Heinz Conservatory, and the Museum of Natural Sciences. These organizations offer a continuum of science lessons that expose students to hands-on science opportunities.

Overall, the primary strategy employed is differentiated instruction through the following:

Content: Teachers can hold novice, average, and above average learners at various levels of readiness accountable for different (not watered down) components of research based content. For example, teachers will make books on energy awareness topics available on a wide range of independent reading levels.

Process: Some students may use films, podcasts, and other audio-visual sources as part of the learning process whereas others may prefer to read narrative accounts and science journals.

Product: Although all are required to present or participate in the culminating service-learning event and are evaluated on the same rubric criteria, the actual student contributions to the project can be varied. Again, one team of students may develop a webpage, another team may develop a presentation board, and another team may present a series of sequence cards illustrating our nation's timeline relative to renewable and nonrenewable resources.

These strategies and others are detailed via the online version of the School District of Philadelphia's Access to the Core Curriculum Strategies Guide: Resources for Effective Teaching. Further, they are accomplished through the guidelines offered in the service-learning component discussed in the *Grade 6 Science Core Curriculum*.

NOTE TO SPECIAL EDUCATION TEACHERS

Sample IEP Objectives:

The following is a typical IEP Goal intended for the Interpersonal Communications domain based on the Reading, Writing, Listening, and Speaking PA State Standard 1.8.6 B which states: Conduct inquiry and research on self-selected or assigned topics using a variety of appropriate media sources and strategies with teacher support. The following is an example of how this goal is compatible with goals and objectives of this curricular unit.

IEP Goals and Objectives
Domain: Life Skills - Interpersonal Communication
Goal 1: (Student name) will conduct inquiry and research on self-selected or assigned topics, issues, or problems using a variety of appropriate media sources and strategies with teacher support (1.8 B).
Objective 1: Given a scenario or authentic event, student will communicate a problem, (student name) will design or create a solution using drawings, technology, and/or written compositions according to rubric criteria.
Objective 2: Given opportunities for collaboration and/ or community based instruction, (student name) will research and present solutions that involve the use of technology, e.g., communication, and transportation using a variety of technological resources to accomplish this task according to rubric criteria.
SDI 1: Teach skills of independence, i.e., paying attention;
SDI 2: Use the computer;
SDI 3: Use graphic organizers

Example of Adaptations to Content for Teachers of Students with Autism Spectrum Disorders and/or with Non –Verbal and/or Emergent Reading Behaviors:

The Pennsylvania Alternative State Assessment (PASA) given for students with severe cognitive disabilities offers students opportunities to respond to questions similar to the following:
1) When presented with three pictures of a water heater, a campfire, and a computer, selects the picture that would require using natural gas.
2) When presented with three pictures of a windmill, a solar energy panel, and hydraulic fracturing equipment, select the picture, which represents a nonrenewable resource.
It should be noted that the nonverbal learners often have strong receptive language and listening skills and will benefit from being in groups with verbal learners. Again, the access to technology inclusive of audio, text-to speech, and photographs serve as excellent access points for all types of learners.

Objectives:

1) When presented with the opportunity to research a current issue relative to areas of science, you will use technology, collaboration, and higher order thinking skills in order to create a public awareness campaign about "hydraulic fracturing" and related issues for the staff, students, and members of the local community.
2) Given the results from your research and collaborative efforts, you will design, create, and/or compose technology-based products of learning and share them with the participants attending your public awareness campaign.

Assessment Criteria:

1. Formative Assessments will be determined by individual teachers in addition to those suggested throughout the unit.

2. Specific rubrics criteria can be adapted to those commonly used by participating teachers in related activities.
3. Summative Assessment for the Service Learning Project is according to the Service Learning Project Rubric in the *School District of Philadelphia Science Core Curriculum Grade 6.*

Classroom Activities:

Before:

Student-Evaluation of Interest in Science: Before embarking on the lessons of the unit, teachers can compose or use a pre-written version of a Student Science Inventory (if one was not already administered in the beginning of the school year). Questions on such an inventory would include asking students about favorite topics in science, experiences with hands-on experiments, and favorite scientists in history or contemporary times. This is also an excellent time to ask students about their access to and experiences with technology. Teachers can inquire if the students have experience completing PowerPoint projects, iMovie/iDVD films, and Comic Life applications as a result of experiences at home, other classes, and/or in other schools they may have attended. Teachers may also inquire about whether or not students have technology/internet access at home.

During:

This unit is divided into four distinct areas followed by a final Service Learning Project. Three are mirrored after commonly used strategies in literacy classes that allow students to make different types of connections as they read/listen to, and learn. They are as follows: Text-To-Text Connections, Text-To-Self Connections, Text-To-World Connections, and an original called Classroom-To-World Connections.

Segment One: Text-To-Text Connections

Objectives:

1) When presented with a myriad of materials ranging from reading materials on the students independent reading levels and audio-visual materials such as films, websites and other resources, students will research and compose either written responses in a Word document, dictated responses via taped recordings, cloze summaries and the like to the questions presented.
2) Students will document citations using Bibme.org or another online citation resource.

Suggested Research Sites:
1) http://www.citizensgas.com/: See For Kids Link-Natural Gas Science and
2) http://www.eia.gov/kids/energy.cfm?page=2 and go to the link Energy Sources: Nonrenewable Energy Sources-Natural Gas

In addition to the suggested sites, students are expected to use search engines to uncover more information about topics. Additional sources are listed in the Teacher and Student Sources section of this unit.

Suggestion for differentiation of content:
Teachers can have students complete research in groups. The following example displays a set of questions listed according to complexity.

GROUP "NATURAL GAS"
What is shale and where does it come from?
Who uses natural gas?
Why is natural gas described as an environmentally friendly resource?
Why is natural gas not considered an environmentally friendly resource?
Is it a renewable or nonrenewable resource?

GROUP "MARCELLUS SHALE" (This group may require less teacher guided support.)
What is the Marcellus Shale and where is it located?
What is taking place at different locations relative to the Marcellus Shale?
What technique is being used to extract this material?
What are the potential problems relative to using this resource?
Who are the participants in the Marcellus Shale "drama"?

Tiered Choice Board Research Based Writing Activity:

In this activity, students will use independently gathered research as they engage in the roles of energy detectives. Four groups will each serve as detective teams in order to uncover literature ranging from "propaganda to technical writing". In doing so, students will understand how issues about the effects of fracking in the Marcellus Shale regions can be presented from multiple vantage points. Students must be able to apply Reading, Writing, Speaking, and Listening standards based strategies from PA Standard 1.9B to discern fact from opinion, presence of bias, bandwagon approaches, and persuasive techniques used in the media and/or literature. The questions are tired as they increase to the "higher order taxonomy of questioning."

Group One: Identify
Students will review several types of sites about "fracking"/natural gas and/or other related topics to determine which ones present factual information and those that present opinion based information or a combination thereof.

Group Two: Evaluate
Students will review several types of sites and magazine articles about "fracking"/natural gas and/or other related topics such as "water quality issues" to evaluate for elements of bias, the presence of scientific/technical information, use of bandwagon approaches, and persuasive techniques.

APPLICATION OF RESEARCH ACTIVITY:

The differentiation occurs in the "product" because student groups can decide what type of end product they will present

Group One: Analyze and Design: Students will create an advertisement about the pros or cons of using natural gas, horizontal drilling, and/or hydraulic fracturing using iMovie, iDVD, or other formats.

Group Two: Assess and Appraise: Students will assess hazards of hydraulic fracturing and present them in contrast to industry claims using iMovie, iDVD, or other formats

Sample of a Modified Task for Students with Severe or Other Cognitive Disabilities:

Students will view pictures and identify ones that require use of fuel. This is a commonly used strategy from the Pennsylvania Alternative State Assessment (PASA) administered to students with severe and other cognitive disabilities. Another modified task is to allow students to sort images of renewable and nonrenewable resources made from student created sketches, clip art, or other cut out images assembled in cooperation with an art teacher during expressive arts classes.

Note to Teachers about Background Exploration Texts and Materials Available In Centers:

An important component of this unit involves allowing students to have ongoing access to designated books (easily obtained from the Free Library Children's Department) about rocks, energy, and other related topics. Teachers participating in Community Based Instruction trips can have students use the card catalog-system to locate books and allow the students can pick them up during community-based outings. In terms of access to other materials, teachers can have students send emails or letters to nearby science university departments requesting samples of shale.

EARTH SCIENCE CONNECTION:

Part One: Methane Research Activity

Teacher will lead students to examine claims put forth by natural gas businesses on sites such as (http://www.naturalgas.org) versus the peer reviewed scholarly research regarding methane emissions from "shale-gas production." Please note at least one scholarly peer reviewed research paper is available for public review by guiding students to energy "shale gas emissions"- Cornell research' in their search engine bar and a more student friendly version is available on Shale Gas: The New Kid On The Block from http:// www.youngzine.com/Our Earth. This can be done in computer lab or with an LCD projector and laptop with the teacher serving as the facilitator of a whole group "shared reading" style investigation. The second experiment allows students to understand the qualities of shale as it relates to natural gas.

SCIENCE EXPERIMENT ONE:

Objective:

Students will engage in the following "Making Methane" experiment derived from data in the Methane Research on the site
http://www.citizensgas.com/ngsw_site/html/teachers3b.html

SCIENCE EXPERIMENT TWO:

Objective:

Students and teachers will complete experiment "Rocks That Trap Gas" from the site
http://www.citizensgas.com/ngsw_site/html/teachers3b.html
Technology Connection: Both experiments will be captured on video or Webcam technology. This will be viewed by visitors to the Service Learning project event and/or on a student designed website.

Please note teachers have the options to create heterogeneous groups and assign students responsibilities in the groups as a way of completing these experiments. As educators, you know the best way to accomplish and carry out these experiments in a safe and effective manner based on the students in your class.

Segment Two: Text-To-Self Connections

Objectives:

1) When presented with a variety of print and internet based resources, students will engage in activities to describe, demonstrate, and or judge the roles and impacts of energy and/or natural gas in the home, school, and community.
2) Given the information, students will make connections and later develop multi-media presentations about how "fracking" and the use of natural gas impacts their lives and/or the lives of others.
3) Given online access, students will compose an online poll about hydraulic fracturing. The following email address will allow students to request access to a site where they can generate questions and post an opinion poll for national response.
Kidsphere-request@vms.cis.pitt.edu - *Internet for Kid's* book for details

TAKING ACTION:

Students will create a survey to distribute to peers and school staff.
Teachers will make sure the students include an opening question in the survey that first asks respondents to indicate whether or not they use natural gas in their homes.
If the respondents indicate they use natural gas in the home, they will also be asked to complete and return the Home Safety Inspection (see http://www.citizensgas.com- Link Home Inspection. Also, students will make multiple copies of this document to have

available for distribution during the Public Awareness component of the Service Learning project).

MATH CONNECTION:

1) Students will record the number of surveys sent as well as the number of respondents that returned surveys indicating they use natural gas in their homes.
2) Teachers can enlist assistance from a math teacher to compose statistical analysis using basics such as 40/50 respondents said or 80% of those surveyed said… in addition to analyzing the data through the composition of spreadsheets or other types of analytic tools.

Background Resources:
1. http://www.citizensgas.com/Natural Gas Safety World: suggested links for Adults and Kids: The following links available through this site serve as excellent enrichment resources to build background information and energy awareness in students Energy Efficient World; Bust Energy hogs; Fire Safety as well as for students not using natural gas in their home.
2. Students will visit http://www.eia.gov/kids/energy.cfm?page=2 and go to the link Energy Sources: Nonrenewable Energy Sources for additional engaging activities and even games that enhance content interest and acquisition.

Affective Learning Activity:

The following is to help students understand the plight of some citizens in fracking communities (not exclusive to the Marcellus Shale region) as their water is contaminated and not fit for consumption.

Life without "convenient" water access for a day activity: Students will create a chart listing all the ways they use water on a daily basis such as showers, hand washing, and cooking. After, students will place an X next to the column indicating how water was used every time they use water in that manner during a twenty-four hour (or more) period. The X will indicate the unavailability of water and help students to internalize the importance of fresh water in our everyday lives. After, students can post their reactions on a class blog page.

This activity sets the stage for a closer examination of water related issues and is intended to build empathy among students for students for some citizens in the Marcellus Shale region who are experiences challenges with the water in their homes. Students will understand the value of water and that it is indeed a commodity we get through technological advances such as water treatment. The third unit component offers student exposure to water related issues.

ADDITIONAL RESOURCE FOR AFFECTIVE LEARNING ACTIVITY: Annual Drinking Water Quality Report 2010 available online from the Philadelphia Water Department

FORMATIVE ASSESSMENT:

Objective: Students will complete Frayer Organizers /Four Square organizers as a check in of understanding as well as a means of visual representations of learning on the following topics: Natural Gas, Horizontal Drilling, Hydraulic Fracturing (Fracking), Marcellus Shale. This will allow teachers to access general understanding of student research skills and acquisition/application of data through use of paraphrased definitions, examples, non-examples, sketches, and minimum three-sentence summary or "Tweets" Writing Connection: Given "identify, verb it and complete it" as an effective summarizing strategy, students will compose a three to five sentence summary. Teachers can present a rubric beforehand to ensure students understand expectations for completion.

Segment Three: Text-To-World Connections

Objective: When presented with a myriad of student friendly, advanced, and audio-visual presentations such as films, websites and internet based resources, students will respond to the following questions and identify the source of that information

Advance Preparation: Teachers will secure a copy of *GasLand* documentary listed in the sources section of this unit.

Description of Activity: The class will view *GasLand* documentary and Sierra Club online videos on site listed in the sources section. Please prepare students for the probability or need for multiple viewings. Teachers can also visit websites in advance to secure specific portions of *GasLand* applicable to the questions the students are seeking answers for.

GROUP QUESTIONS:

- According to *GasLand* and Sierra Club videos, what are some of the potential hazards of engaging in hydraulic fracturing for humans, animals, and forests?
- What are some of the financial benefits?
- What are some things everyday citizens can do in order to address concerns relative to natural gas production issues?

(Teachers and students can generate additional questions using a chart, KWL organizer, or other effective learning strategies).

APPLICATION OF RESEARCH ACTIVITY: Students can save responses on a Word Document and/or tape recordings and later compose them for publishing on a class blog or website.

MOVIE SNACK /NUTRITION CONNECTION:

Before viewing films, students can create snacks reminiscent of "critters" found in natural habitats such as "ants on a log" made of peanut butter and raisins spread on celery

sticks), “caterpillar” watermelon triangles with blueberry eyes, and “broccoli tree” treats with ranch dipping sauce.
If your school partners with Eat Right Now program –ask your educator for assistance.

COOPERATIVE GROUP ENVIRONMENTAL SCIENCE & LITERACY ACTIVITY:

Objective: Students will understand the relationship between the environment and food chain.

First, teachers will complete a read aloud of the book titled Trout are made of trees? After reading the book, students will create a paper based book or multi-media presentation modeled after the Trout are made of trees? titled “Natural Gas...” (Students complete title)

Book components:

- Where does natural gas come from?
- How do we get it?
- How do we get it to our homes, businesses, and vehicles?
- TIPS for Natural Gas Companies to Keep Environment Safe
- Tips for Consumers Using Natural Gas

Excellent Resource for Further Information to Complete This Project:
Visit http://www.eia.gov/kids/energy.cfm?page=2 and go to the link Energy Sources: Nonrenewable Energy Sources

Examples/Choices of How to Create Books:

- Flipbook Style (Accordion)
- Comic Life Application via computer (Students can use clip art or upload photos)
- Big Book Style
- PowerPoint

FORMATIVE ASSESSMENT: WRITING CONNECTION

Differentiation Strategy: Choice Board

- Write an informational piece about natural gas to educate a community.
- Write a persuasive piece to persuade a community about the hazards of extracting natural gas.
- Write an entertainment piece about natural gas from an animal’s or trout’s, or fledgling economy perspective.

There are other differentiated choice options you may use in formative assessment. Please note some may require deeper research; however, you can lead students in this deeper research by using background information presented in this unit. Also, teachers can read and apply background research presented by colleagues in the Teacher Institute of Pennsylvania as well.

Differentiated Writing Strategy:

RAFT (Role, Audience, Format, Topic): Students will compose communication in various roles to different audiences using different topics.

- You are water being used as fracking fluid. Write a letter to a drilling company expressing your concerns about how you are being used.

- You are a child of a parent who got employment as a result of Marcellus Shale. Write a persuasive letter to a person opposing drilling in the Marcellus Shale region highlighting the benefits of "fracking" for the community.

- You are a drilling company owner. Write an article responding to community activists opposing your company's fracking endeavors.

- You are a homeowner living near a fracking site. Write an email to your governor or senator explaining how the fracking is impacting your health (and hearing).

These RAFT responses can be saved on a Word and published on a WIKI, Blog, or Web site.

Objective:
1) Given data about natural gas, students will gain knowledge about the role of technology development in homes and in transportation as it relates to developments in natural gas industry.
2) Given online access, students will view web-based presentations about The Uses of Natural Gas:

- Home –Show Video energytomorrow.com
- Cars –View Website http://autohowstuffworks.com/fuel-efficiency/alternative-fuel/ngvl.htmHow
- http://www.citizensgas.org/: shows how to use natural gas cars video

ACTIVITY: Students will complete exit tickets after viewings which will require a written/dictated response indicating:

- 3 Things We Use Natural Gas for
- 2 Things I Learned
- 1 Thing I Would Like To Learn More About

(Students can research this last item as a homework or other independent learning assignment)

Segment Four: Classroom To World Connection:

Objective: Given internet access and exposure to guest speakers, students will understand how the rules and consequences used in our classrooms have real world applications.

RULES, PROCEDURES, AND CONSEQUENCES RESEARCH:
Students will use information from *GasLand* and internet sites to find out about the rules and regulations governing drilling operations and the activities of drilling companies.

ACTIVITY: Students will complete another version of 3-2-1 in order to reflect on what they learned from their research. It is important to note students receive this guide beforehand in order to direct and guide them in their research.

- 3 Regulations Affecting Drilling Companies
- 2 Regulations Drilling Companies Are Exempt
- 1 Law Drilling Companies Are Exempt From

SCIENCE IN PARTNERSHIP WITH BUSINESS AND COMMUNITIES:
THE QUALITY OF INTEGRITY

Students can complete additional research on these issues and generate their own types of organizers or select ones they are already familiar with using in order to record information:

1. Financial gain amongst citizens who lease their land or wells to drilling companies
2. Investments & Job availability in drilling regions
3. What happens to the land and the communities after the drilling companies leave?

The following two online articles serve as excellent internet based starting points to complete this research and others are listed in the Students & Teacher Sources section of this unit:

- Extensive ad campaign plays up benefits, ignores hazards of shale drilling - Pittsburgh Tribune-Review http://www.pittsburghlive.com/x/pittsburghtrib/s_742853.html#ixzz1Prz5f5K1
- http://pittsburgh.cbslocal.com/2011/06/02/marcellus-shale-industry-offers-job-opportunities/
- http://fracfocus.org/regulations-state

Interactive Writing Activity

Objective: Using an interactive writing strategy, students will compose a letter inviting a representative from a natural gas company or the Philadelphia Gas Works (PGW) company to serve as a guest speaker.

Connection Activities/Options:

1. Students will compose a letter with teacher on chart paper or Word document using LCD projector inviting a guest speaker from a natural gas or PGW company.
2. Students will also invite a guest speaker from a local environmental group.
3. Students will generate five to ten questions for each speaker preselected.
4. Students will interview guest(s) using predetermined questions.
5. Students will videotape using webcam or other technology and (written consent) forms.

The recorded interviews will be shown via website or short video during the service learning community event.

The following are extensions to enhance learning and allow for extended inter/multi - curricular extensions:

SOCIAL STUDIES CONNECTIONS
Historical Connections: In collaboration with the social studies teacher, teachers may wish to compare and contrast via Venn Diagrams "natural gas rush" to the "gold rush" and oil discoveries in early 19th century America.

The following site is an excellent starting point for this activity.
http://www.historyonthenet.com/American_West/gold_rush.htm

EXPRESSIVE ARTS CONNECTIONS

Art: Teachers can collaborate with art teacher in order to illustrate responses to Marcellus Shale issue.

Example: Students can cut and paste a map, highlight Marcellus Shale region, and place a red cut out heart, with an image of water bottle shedding tears to depict the an opinion of the water issue. Also, students can choose a smiling image of a dollar sign instead of the heart based on their own personal position.

Music:

- Amy Grant video: "Big Yellow Taxi" - This song emphasizes how humankind often alters the environment in order to make technological advances. (available online for free)
- The Fracking Song: This video is not only entertaining but also informative as it summarizes the fracking issue in a most creative song (also available online for free)
- An original song titled: "Natural Gas" sung to the tune of Twinkle Little Star… (students complete the lyrics) "Fracking, natural gas for sale, we get it from the Marcellus shale –…"

Segment Five: The Culminating Event: Service Learning Public Awareness Presentation

Objective: Given results, data, and materials researched during previous activities, students will share results with community of peers, school staff, and neighborhood community (including community partners such as Bartram Garden's staff) during Earth Week or other appropriate time during the school year.

Suggest Theme/Title for Service Learning Event:
WHAT EVERY COMMUNITY MEMBER SHOULD KNOW ABOUT NATURAL GAS (AND OTHER ENERGY AWARENESS TOPICS)

Setting the Stage:
Cut out Paper Buttons and write on several individual ones: Yes/No/I Don't Know

Guest Assessment Project:
As guests enter the designated presentation/information area, they will select one of the three circles or buttons indicating their awareness of natural gas and "fracking" issues. After leaving, guest can complete a student created project evaluation offering before and after criteria.

Students will set up an area or designated room in their school building in order to display materials and online products of learning such as Blog, student produced websites, and/or other multimedia presentations.

Teachers can learn about types of multi-media options and how to complete them using the following user-friendly sources as starting points.
Blogs, wikis, podcasts, and other powerful web tools for classrooms and Internet for kids.

SAMPLE SERVICE LEARNING COMMUNITY EVENT PRESENTATION OPTIONS:

- Compose and distribute newsletter or post an online newsletter for community based on research and previous written material.
- Computers opened up with displays of websites, blogs, and podcasts for public listening/viewing work
- Films playing in the background.
- Diorama displays
- PowerPoint presentations and student created book
- Audit results
- Safety presentations about natural gas
- Filmed interviews of guest speaker
- Live or taped Science Experiments conducted in Segment one

Additional Note: Students may want to introduce other relevant energy awareness topics such as conservation and types of energy in order to support community awareness about these issues.

Service Learning Project Evaluation: Teachers will apply rubric assessment criteria as suggested in the Grade 6 Science Core Curriculum

END OF PROJECT STUDENT EVALUATION:

Objective: Given written, dictated, and/or illustrated response options, you will respond to the following questions:
1. What are some of the ways we can meet our energy needs in the United States?
2. What could we do to meet our growing energy needs if we didn't engage in hydraulic fracturing?

3. How is vertical drilling different from horizontal drilling?
4. What is your opinion about hydraulic fracturing?
5. How come businesses and some communities engage in hydraulic fracturing in spite of risks used to the environment and drinking water supply?
6. How do you feel about using natural gas in your home, school, community, and/or businesses you patronize?

Extension Learning Activities available through: EcoExpress.org and
University of Pennsylvania TIP Unit Curriculum section under the Marcellus Shale link.

Bibliography/Works Cited

Associated Press, The. (2011, May 18). "Pennsylvania: Gas Driller Fined." *New York Times*. p.18. Retrieved from EBSCOhost.

BDO USA (2011, May 24). "Volatile Oil and Gas Prices are #1 Risk to U.S. E&P Industry, According to BDO USA Report." *Business Wire (English)*. Retrieved from EBSCO*host*.

Brownstein, M. (2011, April 2). "The Road to a Clean Energy Future?" *Wall Street Journal - Eastern Edition*. p. C2. Retrieved from EBSCO*host*..

Chazan, G. (2011, June 7). "Stage Looks to Be Set For *Golden Age of Gas*." *Wall Street Journal - Eastern Edition*. pp. C1-C2. Retrieved from EBSCO*host*..

Citizens for Pennsylvania's Future. (2011, April 7). "Groups and Businesses Call on Governor Corbett to Allow Marcellus Gas Well Inspectors to Do Their Jobs." *Business Wire (English)*. Retrieved from EBSCO*host*..

Deutch, J. (2011). "The Good News About Gas." *Foreign Affairs*, 90(1), 82-93. Retrieved from EBSCO*host*.

Economist, The (12 May 2011). "The need to be seen to be clean: Natural-gas production is booming, but its green image is in question." 398(8933), 37. Retrieved fromEBSCO*host*.

Efstathiou Jr., J., & Chipman, K. (2011). "The Great Shale Gas Rush." *Bloomberg Businessweek*, (4219), 25-28. Retrieved from EBSCOhost.

Finkel, M. L. (2011). "The Rush to Drill for Natural Gas: A Public Health Cautionary Tale." [Electronic version] *American Journal of Public Health*, 101(5), 784-785.

Fitch, Harold R. (2011, May 11). "Testimony submitted to the House Committee on Science, Space, and Technology, Subcomittee on Energy and Environment Hearing on *Review of Hydraulic Fracturing Technology and Practices*." Retrieved from EBSCO*host*.

Harder, A. (2011, May 21). "A Fracking Mess." *National Journal*, p.19.

Hobson, M. (2011). "Taking 'Fracking' To the Next Level." *CQ Weekly*, 69 (19), 934. Retrieved from EBSCOhost.

Howarth, R. W., Santoro, R., & Ingraffea, A. (2011). "Methane and the greenhouse-gas footprint of natural gas from shale formations." *Climatic Change,* 106(4), 679-690.

Interdisciplinarity. (n.d.) Retrieved June 20, 2011, from http://en.wikipedia.org/wiki/Interdisciplinarity

Langston, L. (2010) "A Bright Natural Gas Future." *Mechanical Engineering*, 132(2), 49.

Marsa, L. (2011). "FRACKING NATION." *Discover*, 32(4), 62-70. Retrieved from EBSCO*host.*

Mook, B. (2011, June 6) "W. Md. drilling on hold again: Md. governor's order essentially bans fracking until 2014." *The Daily Record, (Baltimore, MD.)*

Nelson, J. (2011). "Fracking the world." *New Internationalist*, 442, 24-25.

Norm, A. (2011, May 2). "An Ever-Expanding Waste Line." *Investors Business Daily* p.A08.

Olson, J. K., & Mokhtari, K. (2010). "Making students read in science." *Educational Leadership*, 67(6), 56-62.

Ostlund, Karen. (1992). Science Process Skills: Assessing Hands On Performance Menlo Park, CA: Addison-Wesley Publishing Company.

"PA DEP Kills Directive Requiring Inspectors to Get Approval Before Issuing Violation Citations." http://marcellusdrilling.com/2011/05/pa-dep-kills-directive-requiring-inspectors-to-get-approval-before-issuing-violation-citations/

Peltzman, A., & Saltrick, S. (2005). Beyond The Classroom Door: Essentials For The 21st –Century Teacher. Grand Rapids, MI: Schaffer Publications

Pennsylvania State University. (May 2008). "Research Briefs: Horizontal Drilling May Locate Natural Gas Reserves."*Civil Engineering (08857024)*, 78(5), 39. Retrieved from EBSCO*host*.

Redden, J. (2009). "Frac furor attracts unlikely bedfellows." *World Oil*, 230(10), 4. Retrieved from EBSCO*host*.

Recind Letter to Governor Corbett. (2011, April 7). Retrieved June 2, 2011 , http://www.pennfuture.org/UserFiles/File/MineDrill/Marcellus/DEPinspect.GovRescindLetter_20110407.pdf

Reuteman, B. (2011, January 7). *Natural Gas Vehicles On The Road To Acceptance* Retrieved June 2, 2011, from http://www.cnbc.com/id/40794709.

School District of Philadelphia. (2005) *Core Curriculum: Grade 6 Science*. Philadelphia, PA.

Stuhldreher, T. (2011). "Rettew Flowback Inc. finds footing in frackwater recycling." *Central Penn Business Journal*, 27(12), 3-7. Retrieved from EBSCOhost.

Trefil, J. & Trefil, Wanda. (2009). "The Science Students Need To Know." *Educational Leadership.* 67(1), 28-33.

"What Is Multidisciplinary Integrated Curriculum?" (n.d.) Retrieved June 20, 2011, from http://www.connectedcalifornia.org/downloads/LL_What_is_Multidisciplinary_Integrated_Curriculum_v2.pdf

USA Today (2011, June 7). *Editorials*: "Our view: 'Fracking' with care holds key to energy future." p.8A.

Annotated Resources:

http://Blogger.com

This is an excellent online tool which allows teachers and students to create an online Blog page.

Core Curriculum: Grade 6 Literacy. (2005). Philadelphia, PA: School District of Philadelphia.

Excellent for types of graphic organizers.

Citizens Gas (n.d.). *Natural Gas Safety World.* Retrieved February 20, 2011 from http://www.citizensgas.com/ngsw_site.

This site is an essential student friendly site used to assist the students as they engage in the research portion of the activities.

Drilling Process Video. (2009, January 1.). Marcellus Shale Coalition. Retrieved February 20, 2011 from http://marcelluscoalition.org/2009/01/drilling-process-video/

This is one of many available drilling videos that explains horizontal drilling with visual support.

EcoExpress.org (n.d.). *Earth Force: Erie Students Take Action*. Retrieved June 20, 2011 from http://www.ecoexpress.org/video_detail.php?videoId=140&notes=1,1,1,1

This site will be used as a model for students as they complete their technology based learning products. Teachers will find ideas for many engaging activities on this site, helping students bridge the gap between Environment and Ecology Standards and the impacts of everyday actions on the natural world.

Energy Arcade (n.d.) energytomorrow.org. Retrieved June 15, 2011 from http://www.apienergyarcade.com/smarthouse/

This is an excellent site to generate student interest in energy awareness topics. The learning activity incorporates geography relative its' relationship to energy efficiency topics.

Fox J. (Producer/Director). (2010). *Gasland*. [Documentary]. United States: New Video Group.

This is one of two must-see components of the Text –To-World section. Students will engage in multiple viewings of film or film clips in order to comprehend, analyze, and synthesize aspects of the natural gas issues.

Frazier, D., Kurshan, B. L., & Armstrong, S. (1995). *Internet for kids*. San Francisco: Sybex.

This is an all encompassing indispensible resource for novice to experienced teachers engaged in technology integration as an essential part of learning.

Geology of the Marcellus *Shale* - Museum of the Earth *www.museumoftheearth.org/outreach.php?page=92387/352042*

Excellent resource to include as our students complete research about the Marcellus Shale.

Holmes, D. & Bekker, N. (n.d.) "My Water's On Fire Tonight" (The Fracking Song) [Video] Retrieved May 20, 2011 from http://www.propublica.org/article/fracking-music-video/single-My

Entertaining yet complete who, what, where, when, and why questions relative to the Marcellus Shale.

Lambert, J. (2011, March). "Stepping On The Gas." *Grid*, *15*, 17-19.

This article highlights the activities of an activist who has dedicated her life to creating reforms relative to the "fracking" movement.

Marcellus Shale –PWD Position Paper- (2011, February) Retrieved May 22, 2011 from http://www.phila.gov/water/

This resource gives students a view the position of a local government agency—the Philadelphia Water department.

Oxlade, C. (2004). *Energy: Present knowledge, future trends*. North Mankato, Minn: Smart Apple Media.

This is an excellent student friendly text to include in the student book center.

Pennsylvania Chapter Sierra Club (n.d.) *Welcome To the Marcellus Drilling Resource Page*. Retrieved June 2, 2011, from http://pennsylvania.sierraclub.org/PA_Chapter_2008/Conservation/Energy/MarcellusDrillingResourcePage.htm

This is second of the two must-see components of the Text –To-World section. This site also promotes activism, suggestions for involvement, and offers other links about science information.

Richardson, W. (2006). *Blogs, wikis, podcasts, and other powerful web tools for classrooms*. Thousand Oaks, Calif: Corwin Press.

This is another user friendly book especially useful for experienced as well as novice educators motivated to use technology in their classrooms.

Sayre, A. P., & Endle, K. (2008). Trout are made of trees. Watertown, MA: Charlesbridge.

This children's literature non-fiction picture book teaches about the food web and stream ecosystems. This book was selected to help students understand the potential impact that dumping or spills of fracking fluid could have on fish, habitat, and humans.

"Shale Gas: The New Kid On The Block" (2010). Retrieved June 20, 2011, from http:// www.youngzine.com/Our Earth.

This site allows the only students to add the comments. It is student-friendly and excellent even for modestly equipped reader because teachers can put computers on read aloud mode. Yet by far, this resource does an excellent job of describing the "clean burning" myth in student friendly terms.

United States Energy Administration (n.d.). *Energy Kids*. Retrieved February 20, 2011, from http://www.eia.gov/kids/energy.cfm?

This site is another indispensible site for background information about all types of energy especially to build background info and interest.

Water Quality Report (2010). Philadelphia Water Department. Retrieved May 22, 2011 from http://www.phila.gov/water/Drinking_Water_Quali.html

This report also offers users a visual of water treatment process.

Why Natural Gas? (n.d.). America's Natural Gas Alliance. Retrieved February 20, 2011 from http://anga.us/why-natural-gas

This site is an excellent resource as it offers explanations about and descriptions of natural gas functions, benefits, and related issues. Students will be able to identify that the site is written by a partial source but that it is not a tool of propaganda.

Appendix- Content Standards:

The following represents the Pennsylvania State Standards for Science and Technology that align with the objectives and activities addressed in this curriculum unit:

3.5.7 Earth Science
- B. Recognize earth resources and how they affect everyday life.

3.7 Technological Devices
- D. Apply computer software to solve specific problems.

3.8 Science, Technology, and Human Endeavors
- A. Explain how sciences and technologies are limited in their effects and influences on society
- B. Explain how human ingenuity and technological resources satisfy specific human needs and improve the quality of life.
- C. Identify the pros and cons of applying technological and scientific solutions to address problems and the effect upon society.

4.3.7 Environmental Health
- A. Identify environmental issues
- B. Describe how human actions affect the health of the environment.

4.8.7 Humans and the Environment

C. Explain how human activities may affect local, regional, and national environments.

D. Explain the importance of maintaining the natural resources at the local, state, and national levels.

4.97 Environmental Laws and Regulations

A. Explain the role of environment laws and regulations.

The following represents the Pennsylvania State Standards for Reading, Writing, Speaking, and Listening that align with the inter/multi- curricular goals and objectives of this unit:

1.2 Reading Critically In All Content Areas

A. Read and understand essential content of informational texts and documents in all content areas.

1.4 Types of Writing

B. Write multi-paragraph informational pieces (e.g. letters, descriptions, reports, instructions, essays, articles, interviews).

C. Writing persuasive pieces.

1.9 Information, Communication, and Technology Literacy

A. Use media and technology resources for self-directed learning, group collaboration, and learning throughout the curriculum.

B. Identify techniques used in particular media messages.