Supplemental Materials

SM 1. Question Map Development Process

As described in the article, after we introduce the scenario, students naturally have lots of questions like "What energy do we use in our community?" and "Are we going to produce energy to use in our school?" We build off these questions and encourage our students to brainstorm additional questions. To help focus their questions on the problem, we ask, "How can Virginia become energy independent?" which is the overarching question for the unit. The students brainstorm and record questions individually on large sticky notes, with one question per sticky, and then talk about them in small groups and brainstorm more as a group. Often, the students propose ideas rather than questions, such as "Energy does work," so we help them formulate their ideas as a question. For example, the idea "Energy does work" was rephrased by the student as, "What is energy?" and by another student as, "What can energy do for us?"

After this brainstorming process, students are excited to share their questions with the entire class and naturally begin to look for patterns in similar questions, often noting "Oh, we wrote the same thing!" or "Our group had the same question." As a class, we organize the questions into topically-similar categories.

We took time before beginning this unit to think through the concepts that needed to be taught, drafted a list of questions, and organized them from simple ideas to more complex. So, while we try to honor the student's questions as much as we can, we also know that they will not have enough background to think of questions for all of the concepts that need to be taught in the unit. Therefore, with our draft question map in mind, we ask leading questions to help students develop questions for some of the missing concepts. Then, as needed, we also add questions that address the unit's content/skills learning objectives to address any final gaps. For example, students did not address energy transformations specifically, so we added the question, "How is one type of energy transformed into another?" We took approximately 30 minutes to brainstorm questions and develop a question map.

The students asked many questions and not all connected well with the number of days that we had to teach the unit (2-3 weeks) and the standards that we had to address. For example, students were really interested in the question one group posed, "How much does energy cost?" Yet, this was outside of the scope of the problem. We were not able to do this but one way to honor those questions is to group them together for a Research Day. On this day, they could research a question of interest.

Having students organize their questions related to solving the problem in this way helps them see how what they are working on in a given day fits into the overall PBL unit. They often refer back to the questions that were
created in this question mapping process, so we know they are applying their knowledge to make connections to what they are learning within the unit (e.g., Roth et al.,2011).

SM 2. K-W-L Chart

Question: How is one type of energy transformed into another type?

What do we think we know?	What would we like to know?	What have we learned?

SM 3. Energy Anticipation Guide plus Why? Worksheet (with key)

Mark whether or not you agree or disagree with each statement to the left of the statement. When you're finished with the lesson, decide whether you still agree or disagree and explain why.

Agree	Disagree	Statement	Agree	Disagree	Why?
		1. Energy is the ability to do work.	X		Possible answers - Street lights use electrical energy to make the light work. Gasoline is stored energy that makes a car work.
		2. Moving energy is called potential energy.		X	Stored energy is potential energy and moving energy is kinetic energy.
		3. Energy is measured in joules.	X		Energy is measured in two units – Btu (British thermal unit) and joules. A thousand joules is equal to a British thermal unit.
		4. Energy can be created and destroyed.		X	Energy can be transformed into another sort of energy but it cannot be created and it cannot be destroyed. Energy has always existed in one form or another.
		5. Energy from food gives your body energy to work.	X		When you eat meat and fat, it is converted into energy in your body.
		6. Heat energy moves through conduction, convection, or radiation.	X		Heat energy moves in three ways – conduction, convection and radiation.

Note. This version of the document contains the correct answers. Columns 4-6 would be blank on the student handout.

SM 4. Initial Investigation Guide

How might this tool work?

1. In your group, record your observations about this device.

2. How do you think it might work?

3. What do you think it does?

SM 5. Final Project Directions

Got Energy? Final Project Directions

Focus: Your team is to develop a presentation that shares your plan to help Virginia become energy independent. Your team will share the plan to a panel of experts for consideration.

Team Members: You can have up to four people on your team.

Energy Plan Components:
Your presentation must include the following:

1) The current energy sources used by the different regions of the state.
2) Possible energy sources for our region of the state.
3) The feasibility (how likely are we that we can do this) and efficiency (how much energy will it produce) of each of your proposed energy sources be for our region of the state.
4) For both current and possible, what is the environmental impact of each energy source used in our region of the state. Consider the impact of extraction and/or production of that energy source. Also, include the impact of using the source of energy on our environment.

Presentation Requirements:

The presentation should last for 5-7 minutes. You can make a video, use PowerPoint™, or other available presentation software. Each person in the group must talk for at least one minute in the presentation. Your presentation should discuss the components above.