Youth Education & Interpretation It's in Our Nature

It's Just a Soda!

MISSOURI DEPARTMENT OF NATURAL RESOURCES

GRADE LEVEL:

Upper Elementary/Middle School

SUBJECT AREAS:

Sciences, Social Studies, English Language Arts

DURATION:

Preparation Time: 20 minutes
Activity Time: one to two 50-minute class sessions

SETTING:

Classroom

SKILLS:

Application, Analysis, Synthesis, Evaluation

KEY WORDS:

Raw materials, marketing, life cycle

SUMMARY

When the students are thirsty do they typically drink water or are they in the habit of drinking a soft drink to quench their thirst? In this activity students will explore all the ways that energy is associated with the production and disposal of a typical soft drink.

OBJECTIVES

THE STUDENT WILL:

- Explore the processes involved in manufacturing a typical soft drink
- Identify the steps that require energy during the manufacture of a typical soft drink
- Discuss the environmental impacts of the life style of modern society in relationship to packaged foods, drinks, and goods (extension)

MATERIALS

Five groups each with:

- Non-diet soda can or bottle of same type: with ingredients listed on label
- Poster board and markers or paint sets

BACKGROUND

Most items have a life cycle that starts from obtaining the materials required for its production to its final application and disposal. A study of the life cycle of a product can be used in determining its pricing, optimizing production, or in determining the environmental effects associated with the product (also known as environmental footprint). A typical life-cycle analysis involves the following five steps:

- Extracting, harvesting and processing of raw materials
- Manufacturing, processing and formulation
- Marketing, distribution and transportation
- Product use or consumption
- Management of waste materials (disposal or recycling).

A life-cycle analysis can often reveal hidden costs and impacts associated with the product. Often energy is consumed and waste is produced during each of the above steps during a product's life cycle.

THE LIFE CYCLE OF A SOFT DRINK

Soft drinks begin with purified water. Domestic drinking water is filtered to further remove any impurities and solids prior to making a soft drink. Flavoring derived from natural sources or artificial flavors are then added to the water. Sugar (or corn syrup) is also added forming the soft drink base. The soft drink base is mixed and then "carbonated" by introducing carbon dioxide gas

(CO2) to the liquid. The now carbonated drink is transferred to a filling machine and dispensed into containers and sealed. Often the bottles are heated to reduce condensation and to decrease spoilage. Labels are now applied and the soft drinks are packed into appropriate containers. Next the packaged soda is loaded onto trucks for transportation to local markets and stores. Once at the store the soda is usually refrigerated until the customer buys it. Following consumption the container is either thrown into the trash for disposal or is recycled.

Many of the steps mentioned above involve a significant amount of energy. In some cases the energy required is less than obvious such as energy for transporting empty bottles or cans to a landfill after use. A good place to start a life-cycle analysis is to explore the list of ingredients in a product.

Sugar is a typical soft drink ingredient and an in-depth life-cycle analysis would address the following questions:

• Where did the sugar come from?

• Was the sugar derived from sugar cane?

• How was the sugar cane grown?

• Did raising the sugar cane involve the use of fertilizers or irrigation pumps?

• How was the sugar cane harvested?

• How was the sugar cane transported?

• How was the sugar cane refined?

If the soda drink was packaged in aluminum cans, then where did the aluminum for the cans originate?

Aluminum is derived from bauxite deposits and a significant amount of energy is used in producing metallic aluminum (for details see the activity in this curriculum, Is It Worth It?).

Plastic bottles are commonly used to package soft drinks. Plastics are derived from petroleum. What are the steps involved in obtaining oil, and how is energy involved in this process? As you can see, a full life-cycle analysis can be a very complex process. Many of the items we take for granted every day take many paths before finding their way to our homes.

More than seventy percent of students (age 14) drink soft drinks on a daily basis. There is evidence that the sugar and overall calories present in soft drinks can have adverse health effects such as obesity, increased risk of diabetes and tooth decay. Caffeine present in many soft drinks is derived from the coffee bean and is a stimulant that can lead to nervousness, irritability and sleeplessness.

TYPICAL INGREDIENTS FOUND IN A NON-DIET SOFT DRINK:

CARBONATED WATER, HIGH FRUCTOSE CORN SYRUP AND/OR SUGAR, CONCENTRATED FRUIT JUICE, CITRIC ACID, SODIUM BENZOATE (PRESERVES FRESHNESS), CAFFEINE, SODIUM CITRATE, GUM ARABIC, ERYTHORBIC ACID (PRESERVES FRESHNESS), CALCIUM DISODIUM EDTA (TO PROTECT FLAVOR), BROMINATED VEGETABLE OIL AND FOOD COLORING.

PROCEDURE

WARM UP

Set the stage by asking the students:

• Given the option between a can of soda and a glass of water, which would they prefer to drink when thirsty?

• Ask some of the students to explain why they made this choice?

• Ask the students if they have ever considered the resources and energy required to make a can or bottle of soft drink?

• What responsibility do we have in considering the amount of energy involved in making the products we use?

LIFE-CYCLE ANALYSIS

Review with the students the concept of a life-cycle analysis presented in the background section

Divide up the class into groups based on the following five life cycle categories.

- Extracting, harvesting and processing of raw materials.
- Manufacturing, processing and formulation.
- Marketing, distribution and transportation.
- Product use or consumption.
- Management of waste materials (disposal or recycling).

Give each group an empty soft drink container of the same type (non-diet). Ask the students to locate the ingredients listed on the side of the container.

Ingredients are listed in order of highest concentration to lowest. Discuss with the students some of the energy dependent steps involved in producing the first few ingredients listed.

Review with the class the series of questions presented in the background concerning the production of sugar from sugar cane. This will help the students to envision all the steps involved in producing the soft drink.

Instruct each group to prepare a poster showing the energy-related steps involved in the phase of the soft drink life cycle they have been assigned.

Remind the students to consider the energy associated with the waste generated in each stage of the life cycle.

Consider having the students classify each type of energy used (radiant, chemical, thermal, etc.). Refer to the curriculum introduction for definitions.

After the groups have created their poster, place these in sequence on the wall. Give each group an opportunity to explain to the rest of the class the energy related steps they have detailed in their poster.

ASSESSMENT

After each group has explained their portion of the soft drink life cycle ask the students if they are surprised with how much energy is required to produce a soft drink?

The following questions can be given to the students:

- *How would you create a life cycle diagram for the activities involved in generating drinking water?*
- *What were some of the hidden costs associated with a soft drink?*
- *Compare and contrast the environmental issues associated with the production and consumption of a soft drink versus a glass of water?*

EXTENSIONS

Many of the everyday items we use and consume are heavily packaged and processed. The class can conduct a life cycle analysis of another everyday item (toothbrush, breakfast bar, hamburger) focusing on the environmental footprint associated with its production.

GOING FURTHER

Discuss the following questions with the class:

What are some of the health effects associated with drinking soft drinks versus water or milk?

Are soft drinks a form of liquid candy? Why or why not?

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MISSOURI DEPARTMENT OF NATURAL RESOURCES

MISSOURI LEARNING STANDARDS: Grades 6-8 [K-5 Correlations]

SCIENCE GRADE LEVEL STANDARDS:

Earth and Space Sciences

ESS3 — Earth and Human Activity

Concept C: Human Impacts on Earth's Systems

- **6-8.ESS3.C.1:** Analyze data to define the relationship for how increases in human population and per-capita consumption of natural resources impact Earth's systems. [Clarification Statement: Examples of data include grade-appropriate databases on human populations and the rates of consumption of food and natural resources (such as freshwater, mineral, and energy). Examples of impacts can include changes to the appearance, composition, and structure of Earth's systems as well as the rates at which they change.]
- **6-8.ESS3.C.2:** Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. [Clarification Statement: Examples of the design process include examining human environmental impacts, assessing the kinds of solutions that are feasible, and designing and evaluating solutions that could reduce that impact. Examples of human impacts can include water usage (such as the withdrawal of water from streams and aquifers or the construction of dams and levees), land usage (such as urban development, agriculture, or the removal of wetlands), and pollution (such as of the air, water, or land).]

ENGLISH LANGUAGE ARTS STANDARDS:

Writing

1. Approaching the Task as a Researcher

A. Research [K-5 correlation W3A]

- Conduct research to answer a question, drawing on several sources; integrate information using a standard citation system.

Speaking and Listening

2. Presenting

A. Verbal Delivery [K-5 correlation SL4A]

- Speak clearly, audibly, and to the point, using conventions of language as appropriate to task, purpose and audience when presenting including appropriate volume.

SOCIAL STUDIES STANDARDS

Disciplinary Tools

4. Economic Concepts

Theme 1: Tools of Social Science Inquiry

6-8 Geography

- **A.** Using a geographic lens, evaluate economic decisions to determine costs and benefits on contemporary society.

NGSS:

Earth and Space Sciences

MS-ESS3 Earth and Human Activity

- **MS-ESS3-3:** Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.* [Clarification Statement: Examples of the design process include examining human environmental impacts, assessing the kinds of solutions that are feasible, and designing and evaluating solutions that could reduce that impact. Examples of human impacts can include water usage (such as the withdrawal of water from streams and aquifers or the construction of dams and levees), land usage (such as urban development, agriculture, or the removal of wetlands), and pollution (such as of the air, water, or land).]
- **MS-ESS3-4:** Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems. [Clarification Statement: Examples of evidence include grade-appropriate databases on human populations and the rates of consumption of food and natural resources (such as freshwater, mineral, and energy). Examples of impacts can include changes to the appearance, composition, and structure of Earth's systems as well as the rates at which they change. The consequences of increases in human populations and consumption of natural resources are described by science, but science does not make the decisions for the actions society takes.]

Science and Engineering Practices

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 6-8 builds on K-5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.

- Apply scientific principles to design an object, tool, process or system. (MS-ESS3-3)

Engaging in Argument from Evidence

Engaging in argument from evidence in 6-8 builds on K-5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed world(s).

- Construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (MS-ESS3-4)

Disciplinary Core Ideas

ESS3.C: Human Impacts on Earth Systems

- Human activities have significantly altered the biosphere, sometimes damaging or destroying the natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. (MS-ESS3-3)
- Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. (MS-ESS3-3), (MS-ESS3-4)

Crosscutting Concepts

Cause and Effect

- Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation. (MS -ESS3-3)
- Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-ESS3-1), (MS-ESS3-4)

Influence of Science, Engineering, and Technology on Society and the Natural World

- All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. (MS-ESS3-1), (MS-ESS3-4)

Science Addresses Questions About the Natural and Material World

- Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes. (MS-ESS3-4)