

ACTIVITY 9 The Real Cost

9

Through a simulated shopping activity, students learn about life cycle assessments and the potential impact of their consumer choices on the environment. They explore questions such as: What factors do we use to make decisions about the products we buy? What are the hidden environmental costs of everyday items? Who should pay for these hidden costs?



Subjects

Biology, Language Arts, Environmental Science, Social Studies

Skills

Analyzing, Comparing and Contrasting, Concluding, Determining Cause and Effect

Materials

Student pages and presentation (see [Activity Webpage](#) link below)

Time Considerations

Two 50-minute class periods

Related Activities

This activity introduces life cycle assessment and externalities. It can be followed with Activities 10 and 11, which apply these ideas.

Research Connection

Economists use life cycle assessments to evaluate environmental impacts of products. In the assessment of environmental externalities, researchers are exploring and comparing potential alternatives to traditional extraction and manufacturing in order to reduce or internalize externalities.

Activity Webpage

Find online materials for this activity at <https://sfcc.plt.org/section4/activity9>



Objectives

By the end of this activity, students will be able to

- list three examples of externalities that can result from product production, consumption, or disposal,
- assess product information to make informed consumer decisions about environmental externalities, and
- compare potential impacts of internalizing the environmental externalities of a consumer product.

Assessment

- Use essay responses from the student page to assess students' understanding of externalities and their knowledge of how externalities can be reduced or internalized.

Background

Every product we buy has environmental impacts, which occur at different stages of a **product's life cycle**—the period of time that extends from raw material extraction through disposal. These environmental impacts may take the form of air pollution, water use, **deforestation**, or chemical leaching, for example. By conducting a **life cycle assessment** of a specific product, environmental impacts associated with each stage of the product's life cycle can be quantified and measured. Many of those impacts are externalities. An **externality** is an impact that affects a third party who is not directly involved in the decision made by a producer or consumer. This "third party" could be another person or it could be the environment.

Here is an example of an externality: What happens when you buy a tank of gasoline and drive around a city? The collective **emissions** from automobiles have been shown to lower air quality in cities, which can cause respiratory illnesses. The emissions also contribute **greenhouse gases** to the atmosphere.

Additional background information can be found in the **Section 4 Overview**.

However, neither the buyer nor the seller of the gas pays for the full health costs associated with automobile emissions. The negative health impacts on those not directly involved in the transaction are considered **external** to the market, since they are not included in the selling price of the gas. This is called a **negative externality** since an added or hidden cost is not reflected in the price.

Externalities can be positive as well. A **positive externality** means that effect is beneficial to the third party. For example, a landowner may decide to conserve forested land instead of developing it. While the landowner may receive some benefits from this action, other benefits are **external**, as the action will have positive environmental and social impacts. For example, if you lived next to this landowner, the value of your property may increase simply because many people prefer to live by a forest rather than another house or a business.



Vehicle emissions can lower air quality, cause increased respiratory problems, and contribute greenhouse gases to the atmosphere. These are negative externalities associated with driving gasoline-fueled vehicles.

Cleaner air, cleaner water, and less noise and congestion may be additional positive impacts that you and others reap from your neighbor's choice. This is called a positive externality since an added or hidden benefit is not reflected in the price.

An externality can be addressed, or *internalized*, by adjusting the price of the good or service to account for the benefits or costs to the third party. There are several techniques for internalizing externalities, but whatever the technique, the goal is to decrease the negative impacts (negative externalities) or increase the positive impacts (positive externalities). This can be done by linking the costs or benefits of those impacts to those who are involved in the economic transaction. For example, externalities can be internalized by the following:

- **Producer responsibility:** The producer of a product or service could change a behavior or adopt new technologies or practices to minimize negative impacts on the environment or other people.

- **Government regulation:** The government could pass regulations that force the producer to change their behaviors or to adopt new technologies or practices to minimize negative impacts.
- **Consumer responsibility:** Some consumers could voluntarily pay an additional fee to pay for products or services with fewer negative externalities.
- **Tax:** The government could levy a tax to pay for damages and hazards related to the negative externality.

In the gasoline example, the negative externality could be internalized by using taxes on gasoline or charging a toll for people driving within city limits. These measures would make driving into the city more expensive, which would encourage people to decrease that behavior by carpooling or riding a bus. The costs could also be internalized by enforcing stricter regulations on fuel efficiency or emissions. These measures may make it more expensive to buy or maintain a car. In an economic context, this means that



If a landowner conserves forested land instead of developing it, positive externalities may include improvements in water and air quality.



Systems Thinking Connection

UNDERSTANDING THE BEHAVIOR of a **system** in a practical way requires that we focus our area of study by drawing a boundary around that system. Decisions regarding management of the system will depend on where that boundary lies. For example, if we consider the health of an individual by drawing our boundary tightly around that individual, then our health tips will focus on practices or solutions within that boundary (e.g., medications, medical procedures). However, if we draw our boundary around the city where the person lives, then we might focus on other variables that can affect health (e.g., air quality, water quality, or social influences on diet and exercise). The idea isn't that one level of scale is right and another is wrong. Being able to change the boundary of analysis helps us to consider aspects affecting our system that may otherwise get overlooked. In the context of **systems thinking**, an externality is "external" because it creates an impact beyond the normally considered boundaries of the system. Conventionally, economists consider the marketplace to be the extent of their system. Analysis at this boundary has provided important insights about how prices are set. However, this rather narrow approach fails to acknowledge that everything

happening in the economic system takes place within a larger environmental system.

In the example given in the background section, the emissions from burning gasoline are not taken into account in the transaction between the seller of the gasoline and the buyer of the gasoline because the price does not reflect the negative impact of those emissions. In this activity, students learn that the impacts of a market exchange that occur outside the market are often overlooked. Instructors can emphasize to students that when a process is studied, the system boundaries one chooses can affect the conclusions one reaches.

In the context of greenhouse gas emissions, we have historically drawn our boundaries narrowly. Our concerns about cars tend to revolve around speed, safety, traffic, or the price of gas. These things have clear and immediate costs—in time and money. As systems thinkers, we should consider drawing our boundaries more broadly to include impacts on air quality and climate with the understanding that these impacts also have costs associated with them.

the drivers are being forced to shoulder the cost of decreasing the emissions caused by their automobile use. Or, a portion of the cost of health care could be charged to the oil companies, which they likely would pass on to consumers in an increased price of gasoline. The term "externality" may be a new term for your students. Be sure to take time to make sure your students understand its use before starting the activity.

Teaching This Content

In this activity, teachers engage students in a scenario of how shoppers might make decisions about the products they buy based on knowledge of the product's externalities. The products are those that students might commonly purchase. This activity is meant to prompt students to think about their individual actions and how those actions influence environmental conditions.

Through this activity, students can increase their awareness of their consumer choices. Students may hesitate to express some factors that influence their shopping choices, especially those factors related to cost. You may wish to remind the class that many Americans have budgetary limitations on what they can afford to purchase. The goal of the activity is not to make students feel bad that they cannot afford an organic cotton shirt or guilty that they have a plastic water bottle on their desk. Rather, the important message is that if we want to encourage **sustainability** in a way that everyone can afford, the economic system might need to change. There are both economic and social considerations for all products that are not discussed on the externality cards, which focus only on environmental impacts. These considerations can be part of the overall discussion as students focus on the roles that price, convenience, and habits play



TEACHERS SAY ...

My students loved this particular activity! It was challenging, but fun for them, and they were very engaged throughout! The directions for teachers were very straightforward, and the content fit in nicely with curriculum we have discussed earlier in class.

— Land Resources Teacher, Florida

in our consumer decisions. The specific products available to your students may be different from those portrayed on the card. You may want to adjust the cards to match what is available in your area's stores and markets, as retailers often carry products based on local consumer preference and demand.

Getting Ready



The Activity 9 webpage provides **Teacher Tools** that you can use to become more familiar with this activity's background and procedure (<https://sfcc.plt.org/section4/activity9>).

Download the slide presentation LCA and Externalities from the Activity 9 webpage and review it to determine how much you wish to present to students.

Make copies of the Product Cards and the Externality Cards, enough for your students so there will not be a delay waiting to read a card at each station.

Each student will need one copy of the Money student page, with pieces cut. Alternatively, you could use nickels and pennies, two different color poker chips, Monopoly™ money, or other items you have on hand to represent money.

Doing the Activity

1. Introduce this activity by asking students to name the factors they typically consider when they buy something. Explain that this activity will involve reflecting on those factors and considering whether they are sufficient.

2. Place the Product Cards around the room, with similar products next to each other. Give each student \$30 in play money and explain that they can use it to buy a shirt, a snack, and a drink. They do not have to spend all their money. Point out where you have placed the Product Cards and note that there are two

similar choices for each product. Ask students to use paper to record their decisions.

3. Instruct students to walk around the room and buy whichever version of the three products they want. To buy a product, students should write down which product they want to buy and its price. Ask them to tally totals for the three products and bring you the correct amount of money. They can do this fairly quickly, relying on their intuition and initial preference for one product over another.

4. Poll students about which products they bought. Keep a tally on the board of the products purchased (see diagram after step 7). Ask students what factors they considered in their buying decisions. Make a class list of the factors.

5. Explain that in addition to factors such as cost, color, and taste, products can be selected based on the environmental impacts that result from the product's creation, use, and disposal. Use the LCA and Externalities slide presentation to introduce students to the concepts of life cycle assessments and externalities.



The **LCA and Externalities** presentation on the Activity 9 webpage will help you introduce students to life cycle assessment, and it also provides examples of positive and negative externalities.

6. Next, place copies of the Externality Cards around the room, and restore \$30 to each student. Instruct students to select and purchase products again, but this time students should consider the externality information before deciding which product to purchase. Have students write down their choices, tally their total, and give you the appropriate amount of money.

7. Poll the class to see which product they bought this time and compare it to the tally from the previous round. See the following chart for an example. Ask students if they see



ANNIE OXABART, UNIVERSITY OF FLORIDA



For the second round of shopping, students make their choices after reading information about product externalities.

any obvious trends in the products selected between both rounds. What factors did they consider this time when making choices? Add any new factors to the class list. If students changed their choices, they are opting to send a message by their consumption. If they did not change their choices, the variables they used to make their initial decision have greater importance than the environmental externalities. That is their choice. The real issue is how should we reduce the effects of the negative environmental externalities (see step 9).

Round	1	2
Cotton Shirt		
Organic Cotton Shirt		
Factors Considered about Shirts		
Farmers' Market Apples		
Grocery Store Apples		
Factors Considered about Apples		
Bottled Water		
Reusable Water Bottle		
Factors Considered about Water Bottles		

8. Split the class into three groups and assign each group one product (apples, shirts, or water bottles). Give each group member

a copy of the Product Assessment student page and instruct students to work together to answer the questions. Each group should select one member to report answers to the whole class.

9. Have each group report responses to the following questions:

- What are the environmental externalities of your group's product? Which ones are positive and which ones are negative?
- At what stages of the product's life cycle do the externalities occur?
- How can the negative externalities be reduced?
- Who do you think should pay to reduce the externalities?
- Did group members' opinions vary based on which product they preferred?

10. After each group reports its answers, discuss the following questions as a class:

- Are there any similarities in the externalities of the different products? *Many of the externalities are related to greenhouse gas emissions or water; they occur in similar stages of the product's life cycle.*

TEACHERS SAY ...

Two new concepts: externalities and internalizing costs. I am glad for all of the additional information to help the students understand these new ideas. The slide presentation on LCA and Externalities was excellent, clear and concise.

—Honors and AP Biology Teacher, Florida

- Who is currently paying the environmental costs of these externalities?

Some are being ignored, which means future generations will pay if the environment cannot absorb the impact. Some, such as the cost of more frequent severe weather events, are covered by insurance, which may be paid by many people when companies raise insurance rates. Similarly, if droughts affect agricultural production and food prices increase, many people will have to pay more when they purchase food.

- How could these hidden environmental costs become more visible so that consumers can make informed decisions about purchases?

Eco-labels, public service announcements, and teaching people to do their own research are a few possible responses.

- What generalizations can you make that may help you choose products with fewer negative externalities?

Buy locally produced food, organic products, reusable products, for example.

- **Systems Reflection:** Give an example of externalities (positive and negative) related to urban or rural forests at a local scale, a regional scale, and a global scale.

Local: *Neighbors of a forest owner might enjoy the increased wildlife or the improved landscape they experience by living next to a forest. A nearby homeowner might not appreciate a tree falling on her house.*

Regional: *Forests help to protect and sustain a healthy watershed that people within the region rely on for their water supply. Forests also attract and support deer herds that can cause automobile accidents.*

Global: *Converting forests to pastures and developments may benefit local landowners, but removes the potential for carbon sequestration for the planet.*

- **Systems Reflection:** Provide one example of an externality not discussed here and describe how



changing the boundary of the system can affect our decisions.

Answers will vary. One example is the action of cutting in line. When the system under consideration is simply you and your friend who wants to cut in line, allowing your friend to cut may seem like a good idea. However, when the boundary is drawn around the entire line, including angry people behind you, allowing your friend to cut may not seem so wise.

- For homework, distribute the Externalities Essay student page and ask students to write an essay to describe negative externalities and how they can be reduced or internalized. Students should pick at least one externality for each pair of products and explain how that externality could be internalized.

Modifications

Instead of dividing the class into groups, you can review the products together or even just examine one set of products.

Examine the Product Cards for challenging vocabulary and edit them as necessary. You can also create a vocabulary sheet to go along with any new terminology.

You can conduct the shopping activity over three days and have the students take home the Externality Cards to read as homework. Bring in product samples for students to see and examine.

Enrichment

Challenge students to select a product and to think outside the box about how to make that product more environmentally friendly. To inspire students, show examples of products, buildings, or other items that are created with zero waste, biomimicry design, or sustainable practices. The Whole Systems and Life Cycle Thinking website listed in the Additional Resources section provides information and examples that may be helpful to get students started.

Additional Resources

The Secret Life of Things

www.thesecretlifeofthings.com

This website provides a set of short animated videos exploring the hidden environmental impacts of everyday things. Each video has a free pack of learning resources.

The Story of Stuff Project

www.storyofstuff.org

This website contains links to several short videos related to how things are created, used, and thrown away. Video scripts and resources are available for using these materials in classrooms.

Stuff: The Secret Lives of Everyday Things

John Ryan and Alan Durning, Sightline Institute, 1997

<http://www.sightline.org/research/stuff/>

This book explores how nine common items are made. Each product is something that you might use or buy, such as coffee, a newspaper, or a t-shirt. The website provides a curriculum guide to accompany the book and a short quiz about the book's content.



Whole Systems and Life Cycle Thinking

Autodesk® Sustainability Workshop

<http://sustainabilityworkshop.autodesk.com/products/whole-systems-and-lifecycle-thinking>

This website contains a short video connecting life cycle assessment to systems thinking. Scroll down to the bottom of the page to download the materials for a class activity on how systems thinking can inform one's assessment of common household appliances.

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TEACHERS SAY ...

I thought the essay was a great way to assess learning and my students showed a high level of mastery on their essays after the activity.

— Earth/Space Science Teacher, Florida

 **Money**



Product Cards

Cotton Shirt
\$5.00



Organic Cotton Shirt
\$16.00



Bottled Water
\$2.00



Reusable Water Bottle
\$10.00



Farmers' Market Apples
\$2.00/lb



Grocery Store Apples
\$1.00/lb





Externality Cards (1 of 2)

Cotton Shirt

Cotton production can involve the use of pesticides. From planting to harvest, cotton is often treated with herbicides, fungicides, and insecticides. Pesticides can be damaging to organisms that live in the soil and can be washed into streams when it rains, polluting waterways.

Cotton fields are also often irrigated. On average, it takes approximately 659 gallons of water to produce the cotton used to make a shirt (Water Footprint Network).

Researchers have calculated that an average cotton shirt has a carbon footprint of 6.34 kg of carbon dioxide (Continental Clothing Co. Ltd, 2009).

Organic Cotton Shirt

Organic cotton is grown without using synthetic chemicals. This means that only natural fertilizers, pesticides, and weeding techniques are used to produce the cotton. As a result, fewer pollutants may enter waterways. Organic cotton is often grown as a rotation crop, which prevents the soil from becoming depleted of nutrients and allows the soil to hold more water. This may allow farmers to use less water for irrigation (Jorgensen et al., 2006).

Only natural oils are used during the cleaning and spinning process. These oils easily biodegrade, thereby reducing the number of times the shirt needs to be washed during production. In addition, only natural dyes are used (Jorgensen et al., 2006).

Researchers have calculated that the total carbon footprint of an organic cotton shirt is 2.34 kg of carbon dioxide (Continental Clothing Co. Ltd, 2009).

Bottled Water

Petroleum, which is a nonrenewable resource, is used to make most plastic bottles, and fossil fuels are required to ship those bottles of water around the world. This is an energy-intensive process that produced over 2.5 million tons of carbon dioxide emissions in 2006 (Pacific Institute, 2012). Not only do these greenhouse gas emissions contribute to climate change, but the whole process uses a great deal of water too. Approximately three liters of water are used to manufacture one liter of bottled water (The Water Project).

Most likely this bottle will be used only once and then thrown away. If it is made of PET plastic it can be recycled, otherwise it will take more than 1,000 years to biodegrade in a landfill (The Water Project).



Externality Cards (2 of 2)

Reusable Water Bottle

This reusable bottle is made from aluminum. Aluminum production is one of the most energy-intensive industries contributing to greenhouse gas emissions (Tufvesson, 2011).

Since the bottle can be refilled from any tap, the transportation cost for the water is significantly lower than for bottled water. The bottle can be reused, which reduces waste. When the bottle is disposed of it can be recycled; in fact, 75 percent of the primary aluminum ever produced is still in use today due to active recycling programs (Tufvesson, 2011).

Grocery Store Apples

In the Southeast, many of the apples we buy come from Washington, as this state is responsible for producing more than half of the apples eaten in the United States. Washington apples travel more than 2,000 miles to the southeastern United States and the trains or trucks that transport them typically use fossil fuels, such as diesel. This results in air pollution and carbon dioxide emissions that contribute to climate change (WSU Extension, 2014).

Apples that travel a great distance are packed in heavy boxes to protect the fruit, which creates more waste. In addition, preservatives are often used to maintain freshness for fruit that travels long distances before reaching the consumer (Lanford, 2011). Washington apples are available year-round in southern grocery stores.

Farmers' Market Apples

Apples sold at a farmers' market in the Southeast may come directly from a local farmer or from a collection of farmers in that state or region. Many farmers' markets sell organic produce and these apples may have spots from insect damage.

Farmers' markets are usually not open every day, or even all day. Apples are only available in late summer and fall, depending on the variety and whether the farmer has cold storage. Because the farmers are local, the money they earn from selling food supports the local economy. Since the apples travel a considerably shorter distance than those sold at the grocery store, transportation fuel consumption, air pollution, and greenhouse gas emissions are reduced. Research shows that the carbon dioxide emissions from transporting locally produced apples can be 40 times less than the emissions for transporting conventional ones, depending on how both are transported (Bentley & Barker, 2005). Also fruit that is freshly picked and sold immediately will be closer to peak ripeness, which could mean increased flavor and nutrition (Nutrition.gov, 2014).



Product Assessment (1 of 2)

NAME _____

GROUP MEMBERS _____

1. Which product did each of you choose during each round? Why?

2. What are the advantages and disadvantages of each product?

Product 1: _____

Advantages

Disadvantages

Product 2: _____

Advantages

Disadvantages



Product Assessment (2 of 2)

3. Which of the disadvantages are considered negative externalities? Which of the advantages are considered positive externalities?

4. At what stage in the product's life cycle do the negative externalities occur? (Hint: The life cycle stages are raw material extraction, processing, manufacturing, product use, and disposal.)

5. How can these externalities be reduced or internalized?

6. Who should be responsible for reducing negative externalities? Who should pay the extra cost? (For example, should the company or producer of the product pay? Should the users of the product pay? Should everyone pay through increased state or federal taxes or subsidies?)

7. Do the responses in your group for question 6 vary based on which product individuals in the group preferred?



Externalities Essay

Using the information you learned from the shopping exercise and the group discussion, write an informative essay to answer the following question: What are externalities and how they can be reduced or internalized? For each product (water bottles, apples, and t-shirts), pick at least one externality and explain how that externality could be internalized.

Remember, a good informative essay

- has a clear introduction;
- states a focus/topic clearly, precisely, and thoughtfully;
- uses specific evidence/information to support and develop the topic and explains that evidence;
- concludes effectively;
- uses precise language; and
- shows proper use of standard writing conventions (e.g., punctuation, spelling, capitalization, grammar, and usage).

You may want to take some time to plan your essay before you begin writing. Be sure to proofread your essay when you are finished.