 Evaluating Sustainability and Lifecycle

**HIGH SCHOOL**

**Green Chemistry & Sustainable Science**

**Teacher Background:**

Green washing is becoming pervasive in our society and students need metrics by which to use green chemistry principles and to make decisions. This lesson will introduce them to tolls to evaluate sustainability and lifecycle. These tools along with the 12 principles of green chemistry can help inform students of how to evaluate ‘green”. Students will need to understand the definition of sustainability and understand the 3 Es before completing this activity. **Social Equity** is often the most difficult E for students to understand. Social equity implies fair access to livelihood, education, and resources; full participation in the political and cultural life of the Community; and self-determination in meeting Fundamental Needs. Equity – everyone gets what is right for them not equality which means everyone gets the same thing. Social equity leaves plenty of room for individuals, households, and communities to seek the mix of economic, social, and ecological assets that best reflects their values.

**Time Required:** 1 x 45-60 minute class period

**NGSS Standards met:**

* **HS-ETS1-3.** Evaluate a solution to a complex real-world problem based on prioritized criteria and tradeoffs that account for a range of constraints including cost, safety, reliability, and aesthetics as well as potential social, cultural and environmental impacts.

**Green Chemistry Principles:** 1 - 12

**Goal:** To have students understand how to evaluate a product or process for “Green”

**Objectives:** Students will…

* Be introduced to the sustainability triangle
* Be introduced to the lifecycle diagram
* Use these tools to evaluate a product

**Materials:**

* Hand outs
* Online access

**Teacher Procedure:**

**How to introduce each evaluation tool:**

***Lifecycle***

* Explain to students that there is no human endeavor which has zero impact upon the environment, economics or other humans. From the day we are born we are a drain on the resources of the world in some way whether it be large or small. You may want to have your students complete an ecological footprint. There are many websites that have tools for this. We particularly enjoy this one. <http://www.footprintcalculator.org/>
* Explain to students that in their quest to be better stewards of the earth they will be making decisions all of their lives whether they become a chemist or a rock star, as to what is “green” and what isn’t “green”. Remember it is all a matter of degrees as every human action has an impact on others and the world around us.
* Explain to students that often chemicals get a bad rap but the truth is that all materials are made from chemicals – everything is chemical based and some chemicals have caused human health, environmental or economic problems so the questions is **How would we intentionally design our chemicals or our products made from chemicals and chemical processes?** Green chemistry is thediscipline which can make sure that chemicals in the future are purposely designed to have a better lifecycle and sustainability rating.
* Go over the example of the lifecycle of a common product.
* Have them choose a product or a material or component of a product that they can identify and have them complete the lifecycle worksheet.
* Some suggestions would be diapers, a laptop computer, a jacket, a car.
* Now move on to the sustainability triangle
* Have the students use the knowledge they have gained by completing a lifecycle analysis of this product or material.
* Have the students evaluate the product or material for sustainability. This may require more research and it will be critical for students to understand the definition of sustainability.

**Perform a lifecycle analysis**

Choose a product or part of a product of your choosing and work your way through the questions below analyzing the product’s lifecycle.

* To help alleviate concerns over the trend to use Life Cycle Analysis (LCA) as a marketing tool, the Society of Environmental Toxicology and Chemistry (SETAC) has established guidelines for conducting LCAs by both governmental and private agencies, as well as developed a code of ethics.

The lifecycle evaluation should include:

**Extraction** – where on the earth did the materials come from? What are the raw materials?

**Manufacturing** – includes waste products, energy usage and packaging. Waste products must be looked at for impact. For example a ton of one waste product in the environment may not be as destructive as a pound of another.

**Distribution** – How does the material travel to where it will be sold?

**Use** – How is it used and what impact does its use have on air, water and human health.

**Disposal** – Where does it go to die? If it is recycled, it is a closed loop or open loop recycling process.

i.e. Closed loop = my recycled material becomes the same material again – aluminum cans

Open loop – my recycled material becomes another product – PETE bottles

Part one – Lifecycle Analysis

1. Make a simple flow chart of where the product or material starts and ends.
2. Now add to that simple flow all of the input and outputs of the product or material you are analyzing. Below is a simple example.
3. Use the lifecycle visual to further organize your analysis

Part two – Sustainability Analysis

1. Remind students of what they already know about the term sustainability
2. Review the sustainability triangle with the students and give them the following website from which they may be able to find the information they need:

[www.thegreenguide.com](http://www.thegreenguide.com)

<http://ethisphere.com/wme2010/>

<http://www.forbes.com/2003/03/26/500sland.html>

<http://www.ecofirms.org/>

**Example: Pencil** Information from <http://www.pencils.com/pencil-information/pencil-making>

1. Basic flow

Tree Saw mill Slat factory Graphite processing Finishing Retail Use Disposal

1. Inputs and outputs

Energy Energy Energy Energy Energy

Water Water Water Graphite Lacquer

Chemicals Wax Clay

Stain Adhesives

**Tree**  **Saw Mill** **slat factory** **Graphite processing** **Finishing Retail Use Disposal**

Wastewater Waste wood Adhesive slurry Air pollution fro Materials are used

Sawdust Wastewater Graphite and clay waste lacquer spray up in the use phase

**Sustainability Analysis**

Environment - Ecologism

3

1

2

3

2

1

3

2

1

Economy - Capitalism

Equity - Socialism

Economy

1. Can I make it and sell it at a profit?
2. Are our employees earning a living wage?
3. Are we being cost effective with our use of resources? Are we being good stewards of nature as a human tool?

Equity

1. Are people treating each other with respect?
2. Are all people of all genders, ethnicities and geographic locations being paid the same amount for the same work?
3. Are employees and customers safe from harm or human health issues while making and using our products?

Environment

1. Are we altering the balance of the earth in an irreversible way in order to make our product?

2. Are we creating pollution in order to make our product?

3. Are we making effective and economical use