



The Road to Sustainability

Closing the loop by achieving zero waste

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Field-tested with: 12th grade students in the Green Careers class, ESNR Academy, Watsonville High School, Watsonville, CA (Winter, 2011)

Concepts: Zero waste, recycling, compost, externalities, waste diversion, natural resource extraction, production, distribution, consumption, and disposal.

Skills: quantitative comparisons, critical thinking, graphing, experimental design, creating a solution to a real world problem

Module Type: Discussion, lab activity, results analysis, and possible field trip

Duration: Two or three 2-h class sessions

Key materials:

- The Story of Stuff film
- Recyclable, compostable, and waste items
- Gloves
- Five trash bags full of school trash
- Bins or cardboard boxes to sort trash
- Local recycling guide
- Waste characterization worksheets and discussion questions
- Eco-packaged products

Science Education Standards:

National: Science As Inquiry; Science and Technology; Science in Personal and Social Perspectives

California: Biology-Life Sciences: 6. Ecology (habitat alteration); Investigation and Experimentation

Overview: Students learn that the products they own go through a materials economy that includes natural resource extraction, production, distribution and themselves as consumers and disposers. Learning that this is unsustainable, students do a waste characterization of school trash and calculate the percent of trash that can be diverted from landfills with the goal of zero waste.

This project is an opportunity for students to learn:

- Natural resources become products, get distributed, consumed, and disposed of in the linear materials economy that is unsustainable and negatively affects the environment
- The key players, environmental impacts, and their role at each step in the materials economy
- There are sustainable solutions to make this linear process circular, including zero waste
- How to complete a waste characterization, graph the results, and examine purchasing and disposal habits while coming up with alternatives to disposable products and packaging.

Background for Teachers

The Road to Sustainability: Achieving Zero Waste

Human consumption and disposal habits are no longer sustainable, as natural resource extraction increases pollution and habitat loss and city landfills are reaching their capacity. This module teaches students about the materials economy of consumer products and how **externalities** (see Glossary) at each step negatively affect both the environment and human health. This module also challenges students to evaluate their own disposal habits by determining the landfill diversion potential of their own trash, ideally followed up by a visit to a local landfill. This is a hands-on, inquiry-based module that allows students to be creative while learning about a major environmental issue.

Science Education Standards Addressed

This module focuses on sustainable consumption and disposal, learning how to evaluate and assess waste habits, and addresses NSES standards A. Science As Inquiry (p.175-176); E. Science and Technology (p.192-193); F. Science in Personal and Social Perspectives (p.198-199), as well as the following SCSCPS content standards:

Biology-Life Sciences, 6. Ecology: Stability in an ecosystem is a balance between competing effects.

- a.** Students know biodiversity is the sum total of different kinds of organisms and is affected by alterations of habitats (p.54).
- b.** Students know how to analyze changes in an ecosystem resulting from changes in climate, human activity, introduction of nonnative species, or changes in population size (p. 54).

Investigation and Experimentation, 1. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing content in the other four strands, students should develop their own questions and perform investigations. Students will:

- a.** Select and use appropriate tools and technology (such as computer-linked probes, spreadsheets, and graphing calculators) to perform tests, collect data, analyze relationships, and display data.
- c.** Identify possible reasons for inconsistent results, such as sources of error or uncontrolled conditions.
- d.** Formulate explanations by using logic and evidence.
- j.** Recognize the issues of statistical variability and the need for controlled tests.
- k.** Recognize the cumulative nature of scientific evidence.
- m.** Investigate a science-based societal issue by analyzing data, and communicating the findings. Examples of issues include irradiation of food, cloning

of animals by somatic cell nuclear transfer, choice of energy sources, and land and water use decisions in California (p.61).

NSES (<http://www.nap.edu/catalog/4962.html>)

SCSCPS (<http://www.cde.ca.gov/be/st/ss/documents/sciencetnd.pdf>);

Materials Economy: The Story of Stuff

What you buy and throw away can generally be separated into luxury goods (something that you do not need for survival, such as an iPod), or a necessary good (something you do need for survival, such as food). This is the story of the “stuff” we buy. Whether the stuff is a new computer, iPod, bag of chips, lawn mower, Barbie doll, box of cereal, or a new car, all stuff has a story. The material we buy goes through a **materials economy**, which is a linear production line that includes the following steps:



You are a major part of both the consumption (or purchasing) and disposal steps in this process. The United States makes up only 5% of the world’s population but consumes and disposes of 30% of the world’s “stuff” (Seitz 2002). By watching “The Story of Stuff” by Annie Leonard you will learn how we extract natural resources from the environment and use them to produce goods, distribute those goods around the world to retail stores, purchase those goods, and finally dispose of them.

Once you understand the materials economy as it runs today, we can start to explore your role in this flow: consumption and disposal. What you chose to purchase has a big impact on how resources are extracted, produced, and distributed. Explore the things you purchase and think about where they come from, how the parts are assembled and how they get into your hands.

You also have a daily impact on **disposal**, the final step in the materials economy. Think about all of the items you threw in the trash today- even make a list. Could you have recycled those materials? Reused them? Composted them? This module also explores how we can reach a **zero waste** economy. A zero waste economy means exactly that: that there is no waste! Many of the products that we dispose of can actually be recycled, reused, or composted; and those that cannot are generally some kind of plastic or petroleum-based packaging that can be manufactured using alternative, recyclable materials, such as paper or glass.

In this module, you will explore the waste habits of your high school or class by completing a **waste assessment** of the trash cans. A waste assessment is done by classifying all the materials found in the trash as: recyclable, compostable, reusable, and trash (landfill bound). You may be surprised how little of actual “trash” is landfill bound and how much you could actually recycle or compost!

Advice to Teachers

There are a few new terms in this module that students may become confused with, such as consumption, externalities, diversion, and compost. It is important to clearly define these terms and reiterate their definition as they are used. Also, it is important to connect the first day discussion of the big picture materials economy to the students personal disposal habits in the same way it is important to connect the waste characterization of the school trash to the larger community. Specifically, make sure the students understand that the recycling and compost that they are throwing away is going to end up in the landfill. Also, students should understand that they can make a difference by recycling and composting as well as choosing to purchase recyclable products with limited packaging.

Our plan was to follow up our analysis of school trash with a field trip to our local landfill, and unfortunately our trip in 2011 was rained out. However, we are planning to repeat this project, and feel the landfill visit is critical, to connect students with their community, and to make the broader lesson about landfill capacity tangible and verifiable by the students.

Project Description

Materials

- The Story of Stuff film (free online: <http://www.storyofstuff.com/>)
- Recyclable, compostable, and waste items for demonstration
- Gloves
 - Latex or nitrile
- Five trash bags full of school trash
 - Collected before or during activity
- Bins or cardboard boxes to sort trash
- Local recycling guide
 - Can be obtained from the city or any local trash hauler. Here is a link to the City of Watsonville recycling guide:

http://www.watsonvilleutilities.org/index.php?option=com_content&task=view&id=31&Itemid=127

- Waste characterization worksheets and discussion questions
 - See below
- Eco-packaged products
 - Such as glass milk jugs or plant-based packaging
- Optional Guest Speaker: Local recycling coordinator

Timeline Day 1: Story of Stuff

- 25 minutes Introductory discussion on materials economy and externalities
- 25 minutes Watch the "Story of Stuff"
- 20 minutes Post-movie discussion on social and environmental impacts and solutions
- 20 minutes Guest lecture talk about achieving zero waste careers AND/OR discuss, using example materials, what is recyclable, compostable, reusable, or landfill bound trash

Timeline Day 2: Inquiry waste assessment activity

- 15 minutes Introduction waste assessments and activity
- 20 minutes Students collect waste bins (optional, can do prior to activity)
- 10 minutes Students break into groups and get worksheet (see below)
- 5 minutes Provide inquiry starting point from worksheet
- 40 minutes Groups complete the waste assessment
- 15 minutes Groups summarize their data
- 15 minutes Groups report results to the class
- 20 minutes Post-activity discussion

Preparation

Download "The Story of Stuff" from the website above.

Watch the "Story of Stuff" and read through discussion questions or prepare your own discussion points surrounding the material economy.

Purchase gloves.

Collect trash bags around the school. One bag per student group is needed.

Collect cardboard boxes or bins for trash sorting. Three bins/boxes per student group are needed. Alternatively, allow students to sort trash outside and/or on tarps.

Make copies of the worksheet (see below), one for each student.

Procedure

1. Introductory Discussion

Pre-movie discussion Points:

1. How do you spend your leisure time? T.V. or shopping? What makes you happy? Friends/family?
 - U.S. spends 4 x more time shopping than Europeans (Cross 1993).
2. What do you need to live? What is a luxury and what is a necessity?
 - Have them think about what they buy during a week/month/year
 - Make columns on the board.
 - Begin to draw the materials economy, starting with consumption.
3. The US is 5% of the world population but consumes 30% of stuff (Seitz 2002) and 30% of the trash comes from us too (Miller 1998). Do you think it is a problem?
 - What is it that we are consuming? Natural Resources? **Draw resource extraction.**
 - Define Natural Resources- what are some natural resources?
 - How do these resources get into these products that you buy? **Draw production.**
4. Where does your stuff come from? Take the ipod, for example.
 - Talk about production and the materials that go into things.
 - Just to make your tiny ipod, you have stuff coming from all over the place: Chrome-South Africa; Aluminum-Brazil, China; plastic-oil; Nickel-Utah (Eaton 2009).
 - Then what happens? It gets packaged and sent to your store. **Draw distribution.**
5. Where does the stuff go when you throw it "away"?
 - See what the students think. **Draw disposal.**
6. Now see what you know before watching the movie. Ask them to examine the materials line they just came up with: **extraction, production, distribution, consumption, and disposal.**
 - What do you think are some environmental impacts at each step? Do you pay for those? If not, what are they called? **Externalities.**
 - What kinds of people do you think are impacted at each step (residents, workers)?
 - Who do you think can make a difference at each step (government, manufacturer)?
7. Think about these issues and where you can make a difference while you **watch the video.**

Post-movie discussion points:

8. Back to the **materials economy**: extraction→disposal
 - What is wrong with the linear formation of this process? Can we go on forever like this?
 - What are the environmental impacts at each step? Do you pay for those? If not, what are they called? **Externalities**
 - Do they have something to do with the \$4.99 radio Annie Leonard mentions in the movie?
 - What people are impacted at each step (residents, workers)?
9. Solutions!
 - Who can make a difference at each step (government, manufacturer)? How?
 - Where can you intervene to make a difference? Not buy? Recycle?
 - Does recycling get to the core of the problem with our waste?
 - The movie talks about Green Careers as a major solution, including Zero Waste!

Zero waste points to research and discuss:

Talk about different materials and what they're made of:

- What items are made to throw away only? Plastic, mixed-materials
- How things are actually produced, such as what the different numbered plastics are.
- How can we make things differently to reduce consumption and waste? Reuse, not buy
- What waste reduction resources do you have in your town?
- Where does waste go? Overseas? Landfill? How much more landfill space do you have in your town?

If time, show this cool music video: <http://greensangha.org/plastics-campaign/>

2. Starting Point for Inquiry

Hand out the activity sheet and have the students read the intro out loud for the basis of inquiry:

"In three years, in 2014, [High school name here] High School is trying to become a "green" high school. They have entered a contest against [rival high school name here] High School to see which school can become greener. The Principals have agreed on many greening points to compare the two schools, such as energy use, water use, cafeteria food production, as well as how much waste they produce. Your Principal is looking to this class to help with the greening process. They have hired you to come back to [your high school name here] to do a waste characterization of the classrooms. Back here today, in 2011, we are giving you a chance to practice! Here today we have trash from classrooms at your high school name here]. Your job today, with your group, is to characterize the trash and report out what you find. Specifically, the Principal

needs to know how much recycling and compost is in the trash, or how much trash your high school name here] can divert from the landfill.”

Explain how there are many ways to do waste assessments and have students brainstorm ways to characterize the waste. Here are some ways that may come up:

- Count each piece, do total pieces
- Weigh each category (paper, plastic, glass)
- Weigh broad categories (recycling, compost, trash)
- Measure percentages
- Measure true recyclables, those that can be recycled multiple times: glass/metal/paper
- Measure types of glass/plastic/trash- green, brown, #1, #2, etc.

Demonstrate/brainstorm how to make a data sheet **and a pie chart**. Examples:

	Recycle items				Trash items				Compost items		
	Weight (g)	#	Est. %		Weight (g)	#	Est. %		Weight (g)	#	Est. %
Plastic #1				juicebox				peel			
#2											
glass											

3. Starting and Guiding Hands-on Activities

1. Break the students up into groups of 3-4 students each.
2. Have them read through the entire worksheet on their own or go through it as a class.
3. Give the students time to decide on an assessment method and to design their data sheet that reflects that method.
4. Have one person from each group come to gather a trash bag, sorting bins, and gloves.
5. Let students begin assessing the waste, making sure to float from group to group asking them questions about what materials are made of and to check if they are sorting correctly.
6. Ask students to calculate the percentage of recycling, compost, and trash in each bag and to make a pie chart.
7. Write the group averages on the board and calculate a whole class average. Create a pie chart representing the class average.
8. Guide students in answering the worksheet questions.

4. Guiding Thoughtful Question-Generation, Design, and Testing:

Pick two pieces of trash and two pieces of plastic from the recycling and ask:

- Are these items necessary?
- How can we make the item or package the product differently for zero waste?
- Pick one item you can reuse- how can you reuse it?
- Discuss producer responsibility- is it the responsibility of the producer to create eco-friendly and recyclable packaging and products?
- Discuss consumer responsibility- we can make a difference by choosing less packaged, more recyclable products to buy.
- Show examples of well packaged products and talk about how those producers demonstrate producer responsibility.

5. Assessment Methods

Recommended approaches to assessment include:

- Review data collect by students
- Review group work and discussions
- Review answers to worksheet questions
- Assess learning of the main idea from class discussions

Waste Assessment Activity Sheet:

In three years, in 2014, [High school name here] High School is trying to become a “green” high school. They have entered a contest against [rival high school name here] High School to see which school can become greener. The Principals have agreed on many greening points to compare the two schools, such as energy use, water use, cafeteria food production, as well as how much waste they produce. Your Principal is looking to this class to help with the greening process. They have hired you to come back to [your high school name here] to do a waste characterization of the classrooms. Back here today, in 2011, we are giving you a chance to practice! Here today we have trash from classrooms at [your high school name here]. Your job today, with your group, is to characterize the trash and report out what you find. Specifically, the Principal needs to know how much recycling and compost is in the trash, or how much trash your high school name here] can divert from the landfill.

1. How can you do this? **Write down the ideas we come up with as a class:**
2. Choose a method from the list above, create a data sheet, characterize the trash and record your results.
3. Make a graph or visual of your results, a pie graph is one example.
(use the back of this paper or your data sheet)
4. As a group, pick two pieces of trash AND two pieces of plastic recycling and brainstorm:
 - a. Are these items necessary? How can we do without them?
 - b. How could we design the product or the package to make zero waste or use no plastic?
 - c. Could use reuse any of the items? How?
5. Present the results of your waste characterization to the class. Also, present the items you chose when answering #4 above.

Glossary

Externality: A positive or negative side effect or consequence of an industrial or commercial activity that affects other parties without the agreement of those impacted parties, and without this being reflected in the cost of the goods or services involved. Many environmental problems are currently treated as *negative* externalities in our economy, because the real costs of pollution, exhaustion of natural resources, and human health damages incurred by the production of consumer goods and services are not factored directly into the prices we pay for those goods and services on the market. Some common examples of *positive* externalities—activities whose benefits exceed prices, and impact third parties in a positive way—include beekeeping (the benefits of pollination exceed the market price of honey); public education; public safety systems; and public provisions for controlling infectious disease.

Reference List

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Seitz, J.L. (2002) *Global Issues: An Introduction*, 2nd edition. Malden, Massachusetts: Blackwell Publishing.