



What's In It? How Is It Made?

Activity no. 1: What's in a Tee-Shirt?

Content area: Technology, Science, History

Grade level(s): 3-5

Objective(s): Students will learn about the raw materials and technology needed to make an item common to their everyday lives: a cotton tee-shirt.

NJ Core Curriculum Content Standards:

NJ Technology Standard 8.2.4.G.3: Evaluate the function and aesthetics of a technological product, system, or environment from the perspective of the user and the producer.

NJ Science Standard 5.4.C: Earth's composition is unique, is related to the origin of our solar system, and provides us with raw materials needed to sustain life.

Background Information for the Teacher:

Few people living in the U.S. today realize where the items come from that they use in their everyday lives. Most of us simply buy what we need – we don't make it. Thus we aren't aware of what raw materials go into making the things we use, we don't know the environmental consequences of obtaining those raw materials, and we don't know the technology of transforming raw materials into the end-user products we buy in stores. In this activity students will explore these connections through an item familiar to all of them – a cotton tee-shirt – and they will develop a sequence diagram illustrating each step in transforming a cotton plant into a wearable item of clothing.

For basic information on where our fabrics (and metals, foods, plastics, paper products, etc.) come from, see the Teacher Information Sheet entitled *What's In It? How Is It Made?*

Time Required: One class period.

Materials Needed:

For each student:

- 1 Word List sheet (see appendix A)
- 1 sheet of plain 8" x 11" copy paper
- Scissors
- Tape or glue

Optional items:

- 1” square colorful fabric swatch
- Small square of colored paper cut into tee-shirt shape
- Cotton balls

Teaching the Lesson:

Have students sit in groups. Each student will be developing his or her own sequence diagram, but focused conversation between students is encouraged.

1. Give each student the materials listed above **except** the tape or glue. (Do not distribute the adhesive until you check their work.) Review the Word List sheet together as a class. Explain that the words will be cut apart and taped/ glued in a sequence to show the production of a cotton tee-shirt. The words represent steps in a pathway from start to finish of a cotton shirt. The arrows indicate the direction of flow. The arrows will be pasted between the words from the start to the finished product (the tee-shirt). Tell students that they will not be putting the words in a straight line on the paper. The sequence will have to curve around the page to make it fit nicely on the blank sheet of paper.

2. Hold up the line drawing of the cotton plant (Appendix B) and/or display internet photos of a cotton plant. Discuss with your students that cotton plants are grown from seed and raised in warm climates. **Do not tell them too much** more about how they are harvested, cleaned, etc. This is the concept we want them to think about for themselves. You may want to glue cotton balls on the picture provided to reinforce that cotton is grown, not manufactured. The cotton balls sold in pharmacy stores are not much different in size from the raw cotton *bolts* that are harvested from cotton plants. Many people have never seen a real cotton plant or a boll of raw cotton, so the picture is vital to a student’s deep understanding that cotton is a plant material.

3. Direct students to cut out all the words on the Word List. Blank ones are provided if they want to add more details to the diagram. Have students lay out the words on the blank sheet of 8”x 11” paper in a sequence they developed. Once they have completed their sequence and you checked their thinking, you may give out the tape/glue. Also the optional materials can be fixed to the sheet at this time.

Some possible questions to ask the students as you circulate among them as they work:

- Which step in the sequence is the place to start? [cotton plant]
Which is the final step? [tee-shirt]
- What do cotton plants need to grow? [soil, water, air, light, fertilizer]
- Once the cotton bolls are harvested, how would you get them to the mill? [truck, train]
- Do you know what the cotton mill does to the cotton bolls? [Simply stated, the mills use various types of machinery to clean the cotton bolls, pull the fibers into long threads, and eventually weave the threads into cotton fabric. The fabric must then be cut to shape and sewn into a tee-shirt.]

Wrap-Up Discussion: The wrap-up is vital to the objective of this activity. Here students will begin to see how many earth materials are necessary to produce something as familiar as a cotton tee-shirt. In this discussion it is vital to always draw the students back to raw materials rather

than intermediate products. For example, steel, glass, rubber, and plastics are needed to make a car, but none of those are *raw* materials; they are manufactured ones.

1. Our starting point was the cotton plant. What does the cotton plant need to grow?

A: Soil, air, water, fertilizer, and light

What is our source of the air, water, soil, and light?

A: All four are natural parts of our environment. Air – more specifically, the carbon dioxide that plants need to grow – is in the atmosphere that we breathe. Water comes to the Earth in the form of rain, snow, or fog as a part of the water cycle. Soil has developed naturally over time as rocks decay upon exposure to atmospheric oxygen and moisture, and as organic materials decay. The light that plants need to grow is energy from the Sun.

Where does the fertilizer come from?

A: Ultimately, most components of common fertilizers come from mines. Raw materials used in fertilizers include phosphate-rich rock, sulfur, coal, limestone, dolostone, gypsum, etc. These materials are used to give us the potassium and phosphorus components of fertilizer, to balance the acidity of the fertilizer, and to provide other elements that plants need for proper growth. The nitrogen component of much fertilizer comes from the air – specifically, methane (CH₄) and nitrogen (N₂), the raw materials needed to form ammonium nitrate (NH₄NO₃).

2. Once the cotton bolls are ready for picking, how do they get harvested?

A: Yes, you can pick them by hand, but that would take a huge amount of time to harvest a field full of cotton! Before the invention of the cotton gin and more modern machinery, picking by hand was the only option. Today harvesting machines make picking quick and easy.

What materials are needed to make these harvesting machines? Where do we get these materials?

A: Iron (for steel) and aluminum are needed for the frame, engine, and chassis. Silica sand, limestone, and trona are needed to make glass for the windshield and windows. Zinc is used as a strengthening agent in the tires. Petroleum, natural gas, and coal are needed to make the synthetic rubber for the tires and the various plastic materials that are used in seats, instrument panels, wire insulation, etc. Copper is used in the wiring, platinum in the catalytic converter, and lead in the battery. All of the materials just listed are extracted from the Earth.

What kind of energy is needed to make the harvester work?

A: Diesel fuel, which is basically kerosene distilled from petroleum.

Where does the fuel/energy come from?

A: Oil wells. Raw petroleum is taken to refining plants for “cracking” to produce diesel fuel, gasoline, fuel oil, etc.

3. Now that the cotton bolls are harvested, what do we do next?

A: Yes, we need to transport them to the mill.

What would you want to use to get the raw material to the mill?

A: Train, truck.

What raw materials are needed to make trains/trucks? Where would we get these materials?

A: The raw materials needed to make these conveyances are similar to those listed above to make a harvesting machine.

4. *Once the raw cotton bolls arrive at the mill, they go through multiple machines to clean the cotton fibers, pull them into long threads, wind it up on bobbins and finally weave it into long lengths of fabric.*

What materials are needed to make the machinery that turns cotton bolls into fabric? Where do we get these materials?

A: Numerous metals are needed to make the specialized alloys that go into the different components of these machines. Copper, of course, would be used for the wiring, and stainless (rustproof) steel for various machine parts that come in direct contact with the cotton. There are many “recipes” for stainless steel, but the two key ingredients are iron and chromium. Nickel, manganese, and molybdenum, all metals that come from mines, are others. High-quality sewing needles, meanwhile, are made from high-carbon steel coated with nickel, gold, titanium, or platinum to prevent corrosion. All of these are mined products as well.

What kind of energy is needed to run the machinery?

A: Electricity.

Where does the energy come from?

A: Most comes from coal-fired power plants, nuclear power plants, and hydroelectric power plants, with smaller contributions from wind energy and solar energy. Uranium is the fuel for nuclear power plants. Hydroelectric power plants derive energy from flowing water, but think of all the mined products needed to build one: the limestone, sand, and rock aggregate for the concrete dam, graphite brushes and copper wire in the generators, etc. Nearly all the raw materials used in building wind turbines and solar panels are mined products as well.

5. As you complete the discussion of the sequence of start to finish of a cotton tee-shirt, students should begin to understand that earth materials are needed for every facet in the manufacturing of the tee-shirt that they are likely wearing today. Though cotton plants are grown, not mined, numerous mined products are needed to build the machinery and provide the energy to turn a cotton plant into a tee-shirt.

Assessment:

- Students demonstrated understanding that every step in the manufacture of a cotton tee-shirt, from growing the cotton plants to sewing the final shirt, involves a variety of mined materials for the process to work.
- Students understand the difference between raw materials (iron ore, coal, petroleum, etc.) and the intermediate industrial products (steel, plastics, glass, etc.) made from those materials.

- Students understand that very nearly all of the raw materials necessary to make the products we use in our everyday lives come from the Earth: from mines, quarries, and oil and gas wells.

Resources:

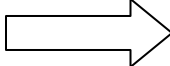
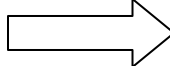
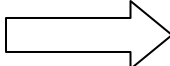
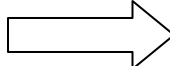
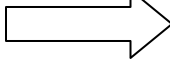
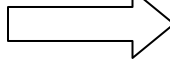
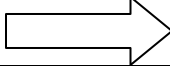

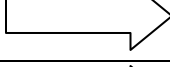
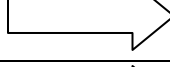
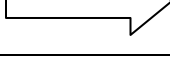
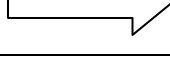
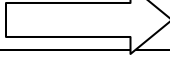
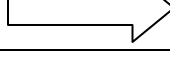
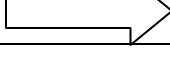
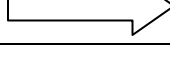
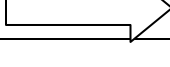
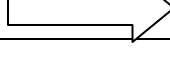
<http://www.tcga.org/CottonKids.htm> This site contain various points of information for kids, including a series of photographs on the growth of cotton plant, and a link to a video concerning inventor Eli Whitney, who developed the Cotton Gin.

<http://www.cottonsjourney.com> This site contains a nice series of photographs showing the life cycle of field-grown cotton plants.

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Trish Rokosz is a retired project director the NJ SSI NSF grant at the County College of Morris and currently (2013) serves on the Education Committee of the Sterling Hill Mining Museum.

Air/Light/Water		Air/Light/Water	
Cotton Boll		Cotton Boll	
Cotton Mill		Cotton Mill	
Cotton Plant		Cotton Plant	
Fertilizer		Fertilizer	
Harvester		Harvester	
Tee-shirt		Tee-shirt	
Truck/Train		Truck/Train	
Truck/Train		Truck/Train	

Word List What's In a Tee-shirt?

Appendix A



Free Clip Art: wpcipart.com

Appendix B