

Lesson 1

Closing the Loop

Introduction

In this lesson students will learn how to make recycled paper. Students will also identify how buying recycled products “closes the loop”, and paper’s effect on global deforestation.

Lesson Overview

Grade Level & Subject: Grades 9-12

Length: 2 hours

Objectives:

After completing this lesson, students will be able to:

- Understand the importance of recycling and buying recycled products.
- Explain the process of how paper is recycled.
- Identify products to be recycled and the significance behind the recycling symbol.

Next Generation Science Standards Addressed:

This lesson addresses the following [Next Generation Science Standards](#):

- **HS-LS2-7.** Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.
- **HS-ESS3-4.** Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
- **HS-ESS3-2.** Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.
- **HS-ETS1-3.** Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

Materials Needed:

- Several 8- by 10-inch pieces of window screen
- Duct tape or wooden frames for each screen
- Scissors
- Two or more 2-gallon plastic dishpans
- Two or more large slotted spoons (depending on the number of dishpans)
- One or two blenders (To speed up the process, obtain a ratio of one blender for up to three plastic dishpans.)
- A copy of “Steps to Make Recycled Paper” for each blender
- Scraps of white and colored paper
- Several towels or sponges (or additional newspaper for removing excess water)

- Internet Access for research

Assessment:

Students will be assessed through the following activities:

- Paper Quality
- Class Discussions
- Class Presentation

Lesson Background**Background Information:**

Trees are grown and harvested on “tree farms” specifically for papermaking. In addition to the trees grown just for the papermaking process, by-products from lumber operations, such as wood chips and sawdust, are also used to make paper. To save transportation costs, paper mills are usually located near the forests where the wood is harvested. The trees are debarked, chipped, mixed with chemicals, and processed in a large steam-heated pressure cooker called a digester. This helps to break the wood down into cellulose fibers. The fibers are then rinsed with water to remove chemicals, unwanted wood contaminants, and dirt.

The remaining water-wood mixture, called pulp, is blown onto a screen and shaken to intermesh the cellulose fibers. Water is drained through the screen, and the remaining sheet of paper passes through a series of rollers where it is pressed. Heated rollers dry the paper. The dried paper is cut and placed on smaller rolls or cut into large sheets.

In 1995 approximately 31 percent of residential waste consisted of paper. This wastepaper could have been recycled. The paper recycling process is very similar to the process of making paper from trees. The paper is chopped up and mixed with water to break down the cellulose fibers back into pulp. Then it is put through a series of cleaning and de-inking processes in which water and/or soap-like chemicals (called surfactants) remove the ink from the paper. Once cleaned the water is drained through the screen, and the remaining sheet of paper passes through a series of rollers where it is pressed and dried. The paper is slit into smaller rolls or large sheets. Later it is cut to desired size.

A single piece of paper may contain new fibers as well as fibers which have already been recycled. Papermaking fibers can typically be recycled five to seven times before they become too short to be recycled again.

Successful recycling requires clean recovered paper which is free of contaminants, such as food, plastic, metal, and other garbage. Contaminated paper can introduce impurities and bacteria into the recycling process. Also, different types (or grades) of paper, such as corrugated boxes,

newspapers, and office paper, are kept separate because the different grades of paper are used to make particular types of recycled paper products.

Recycling paper conserves natural resources, because nearly half of the world's annual commercial wood harvest is used to produce paper. It saves energy, because it takes 30 to 60 percent less energy to produce the same weight of recycled paper as to make the paper from trees. It reduces air pollution from pulp mills by 74 to 95 percent and lowers water pollution by 35 percent. It also reduces the amount of paper going to the landfill, therefore extending the life of the landfill. For additional information about paper and how it is made and recycled, see "Appendix C–VII, Paper."

Recycling symbols on paper products not only look different but also have distinct meanings. The symbol depicting that a carton is made from recycled paper is white arrows superimposed on a black circle. Three black arrows printed without any circular background also indicates that the paper is made from recycled paper fibers. Three white arrows (with black outline), only with no black circular background, means that a package is recyclable, although it may not be made from recycled materials. The three arrows depict the collection, manufacture, and purchase of recycled materials.

Relevant Vocabulary:

- "Closing the Loop"- Recycling products rather than sending them to a landfill, and buying recycled products.
- Conserve- protect (something, especially an environmentally or culturally important place or thing) from harm or destruction.
- Pulp/ Pulp Slurry- Mixture of blended wet paper, to be dried into usable paper
- Virgin Paper- paper from trees with no recycled material involved in production.

Resources:

- Why Recycled Paper is Important:
<http://www.conservatree.org/learn/WhitePaper%20Why%20Recycled.pdf>
- What do your Recyclables become?
<http://www.maine.gov/dep/waste/recycle/whatrecyclablesbecome.html#officepaper>
- Various recycling symbols:
<https://www.recyclenow.com/recycle/packaging-symbols-explained>
- Countries Affected by deforestation:
<http://www.insidermonkey.com/blog/10-countries-with-the-highest-deforestation-rates-in-the-world-362910/>
- General Deforestation Information:
http://wwf.panda.org/about_our_earth/deforestation/

- How recycled paper is made:
<http://www.marcalsmallsteps.com/learn/recycling-process>

Lesson Steps

Preparation

- Read the background information and resources.
- Make copies or project “Steps to Make Recycled Paper”
- Obtain enough materials for your class

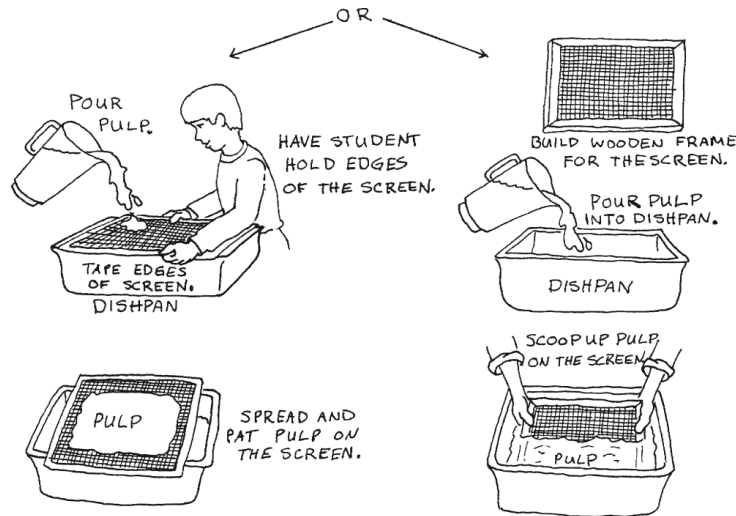
Activity One: Making Recycled Paper

1. Go through the [Marcal Small Steps PowerPoint](#) in the resources section as an introduction to show the students how recycled paper is made on a commercial scale. Then explain that today in class they will be making their own recycled paper.
2. First split the class into pairs or small groups. Print out “**Steps to Make Recycled Paper**” and give a copy to each group. Go over the directions as a class then have the groups begin the activity.
3. Place torn up paper in a blender until the blender is half full.
4. Cover the paper with water. The ratio is usually one-part paper to two parts water. If the paper is not blending easily, you may need to add more water.
5. Blend until the paper has been ground into a slightly runny oatmeal-like consistency. Make sure it is not too thick. This mixture is called pulp slurry.

Note: Adding liquid fabric starch to the pulp will allow students to write in ink on the recycled paper without the ink spreading.

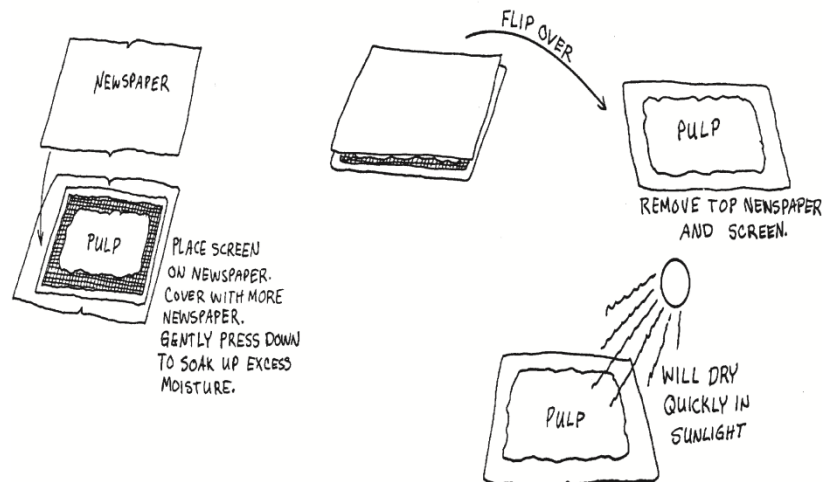
6. If the screen has a frame, pour the pulp slurry into a dishpan. Scoop the pulp with the screen. Spread and pat the pulp on the screen.
7. If the screen does not have a frame, one student should hold the screen taut over an empty dishpan while another student pours the pulp slurry from the blender over the screen. The water should drain through the screen, into the dishpan. Spread and pat the pulp on the screen.
8. Place a couple of pieces of newspaper in the working area and place the screen and pulp on top of them. Optional: Press items, such as flowers, leaves, tissue paper, berries, into the recycled paper.
9. Use a couple of pages of newspaper and gently press down on the paper to soak up the excess water or use dishtowels (because the newspaper could leave black ink on white

recycled paper). Note: If the paper is pressed too hard, the pulp will separate. At this point you can patch up the holes. Or remove the pulp, roll it into a ball, place it back on the screen, cover with newspaper, and gently press the pulp out again. If the pulp has become too dry, you will need to resoak it in the dishpan.



10. Flip everything over (like flipping a pancake). Remove the newspaper from the top and gently lift off the screen. The recycled paper will be resting on top of the newspaper used to soak up the excess water.

11. Place the recycled paper and newspaper in an area to dry (it will dry quickly in the sunlight). If drying overnight, place a heavy object, such as a book, on the paper to keep it from curling. The recycled paper should lift off easily from the newspaper when it is dry.



Activity Two: Deforestation and Recycled Products Discussion and Research Assignment.

1. Ask students if they have heard of the term “Closing the Loop”. Explain that this concept consists of three steps, recycling materials, manufacturing recycled materials, and

purchasing recycled content materials. Discuss the importance of “closing the loop”, and how it helps us to conserve our natural resources.

2. “Closing the Loop” is an important first step to decrease greenhouse gas emissions, and deforestation, especially when it comes to recycling paper products. Have a discussion about the various paper products the students use on any given day. How much paper do they use in a week, a month, a year? Use the information below to give students an idea of how many trees the world harvests for paper production.

Item	Trees per day	Trees per month	Trees per Year
Toilet Paper	27,000 Trees	810,000 Trees	9,720,000 Trees
Paper Towels	51,000 Trees	1,530,000 Trees	18,360,000 Trees
US Sunday Papers	500,000 Trees (each Sunday)	2,000,000 Trees	26,000,000 Trees
Overall worldwide paper production	13,151,600 Trees	394,548,000 Trees	4,734,576,000 Trees

Calculation notes: According to the [Sierra Club](#), it takes about 8 trees to create 1,500 pounds of paper, meaning each tree creates about 187.5 pounds of paper. The online statistics website [Statista](#) states that in 2013, 402.6 million metric tons of paper were produced worldwide. There are 2,204.64 pounds in each metric ton, so by dividing 2204.64 by 187.5, we find that it takes approximately 11.76 trees to produce one metric ton of paper. Which means that to produce 402.6 million metric tons of paper, 4,734,576,000 trees are needed.

3. What are some ways that individuals can decrease their consumption of paper products at home, in school, at the office, ect? Paper production and Deforestation go hand in hand. Lead a class discussion on deforestation, its harmful effects, and areas around the world that are significantly affected.
4. Have students research different countries affected by deforestation and evaluate what these areas are doing to fight deforestation, either individually or in groups. Students should create a report on the deforestation situation in their region. They can do this either in class or as a homework assignment. Most countries are affected by deforestation in some way, however this list shows the counties most severely affected: <http://www.insidermonkey.com/blog/10-countries-with-the-highest-deforestation-rates-in-the-world-362910/> Use Next Generation Science Standard [HS-ETS1-3](#) as a guide for these presentations.
5. Have students present their findings to the class. Led a class discussion about the different strategies countries use to combat deforestation, which strategies are the best or aren't effective enough, and what improvements could be made to these plans.

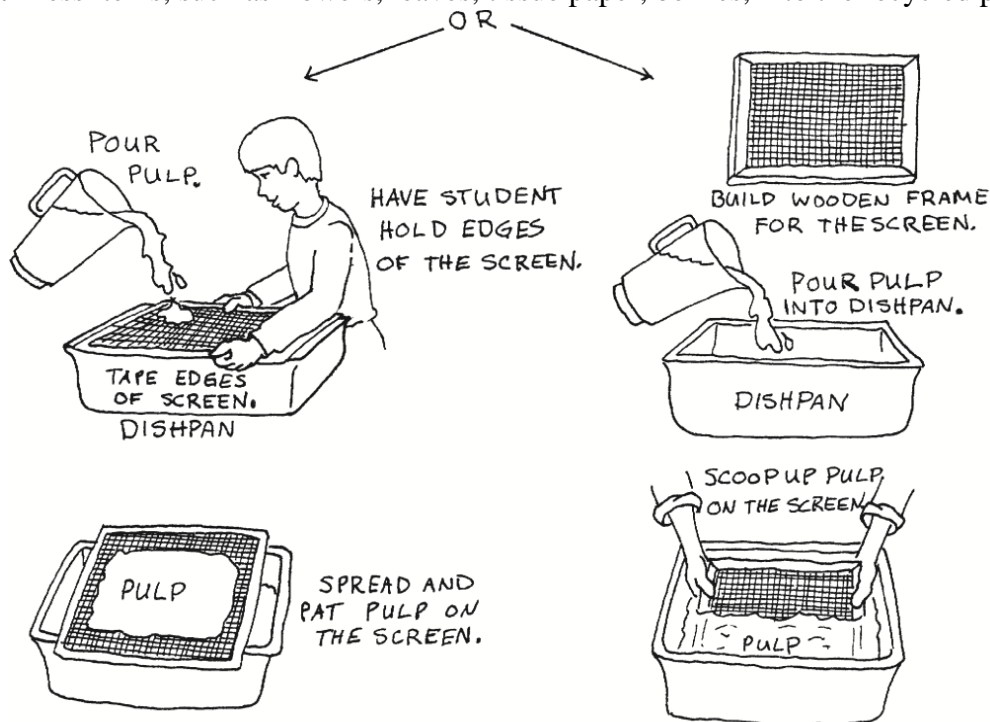
Conclusion

After completing this lesson, students will have a good understanding of how paper is recycled, and the effects that paper production have on the Earth. Students will also have a broad understanding of deforestation, and its affects on countries around the world. They should also be able to decrease their own personal environmental impact.

Steps to Make Recycled Paper

1. Place torn up paper in a blender until the blender is half full.
2. Cover the paper with water. The ratio is usually one-part paper to two parts water. If the paper is not blending easily, you may need to add more water.
3. Blend until the paper has been ground into a slightly runny oatmeal-like consistency. Make sure it is not too thick. This mixture is called pulp slurry.
4. If the screen has a frame, pour the pulp slurry into a dishpan. Scoop the pulp with the screen. Spread and pat the pulp on the screen.
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6. Place a couple of pieces of newspaper in the working area and place the screen and pulp on top of them.

Optional: Press items, such as flowers, leaves, tissue paper, berries, into the recycled paper.



7. Use a couple of pages of newspaper and gently press down on the paper to soak up the excess water or use dishtowels (because the newspaper could leave black ink on white recycled paper).

Note: If the paper is pressed too hard, the pulp will separate. At this point you can patch up the holes. Or remove the pulp, roll it into a ball, place it back on the screen, cover with newspaper, and gently press the pulp out again. If the pulp has become too dry, you will need to re-soak it in the dishpan.

8. Flip everything over (like flipping a pancake). Remove the newspaper from the top and gently lift off the screen. The recycled paper will be resting on top of the newspaper used to soak up the excess water.
9. Place the recycled paper and newspaper in an area to dry (it will dry quickly in the sunlight). If drying overnight, place a heavy object, such as a book, on the paper to keep it from curling. The recycled paper should lift off easily from the newspaper when it is dry.

