

RECYCLING IMPROVEMENTS

STEM Category

Engineering

CAREER PATH

Manufacturing

TOPIC

Optimize a Solution

OVERVIEW

After learning about the amount of paper that the United States uses every year, students will observe how homemade recycled paper is made. Upon examining the result, students will be challenged to refine this process in order to produce a paper product that could be used in their school. Students will work together as they brainstorm and test how to improve the paper-making process until they are satisfied with the result.

STEM LESSON FOCUS

<p>Engineering Design Cycle</p> <ul style="list-style-type: none"> • Refine or Improve 	<p>21st Century Skills</p> <ul style="list-style-type: none"> • Collaboration
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OBJECTIVES

Students will be able to:

- Apply the principals of the engineering design process to refine the recycled papermaking process
- Collaborate with their peers in order to brainstorm refinements and asses the work of others

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MATERIALS

Day 1:

- Handout, double-sided (one per student)
- Scrap paper (notebook paper, printer paper, construction paper, etc.)
- Large bowl or bucket of warm water
- Blender (If one is not available, a fork may be used instead)
- Paper towels
- Cake pan or cookie sheet
- Screen

Day 2:

- Blender or forks
- Scrap paper
- Paper towels
- Buckets or bowls of warm water, one per every 3–4 students
- Cake pans or cookie sheets, one per every 3–4 students
- Screens, one per every 3–4 students

HAVE YOU EVER WONDERED...

How recycled paper is made?

If it would be possible for your school to reduce the amount of new paper it uses every day?

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MAKE CONNECTIONS!

How does this connect to students?	How does this connect to careers?	How does this connect to our world?
<p>Americans use about 31.5 million tons of printing and writing paper each year. This requires at least 535 million trees! Think about the amount of paper you use in school every day, including the paper you write on, the handouts you receive from teachers, and the paper that you read. It's no surprise that schools are a leading contributor to America's paper use!¹</p> <p>Now imagine if students and schools played a role in changing this statistic by reducing the amount of paper they use every year. More and more schools and government agencies are now required to buy and use recycled paper when it is available.</p> <p>In this activity, you'll do your part to see if you can make homemade recycled paper more accessible for use in your school community!</p>	<p>Recycling Specialists work for Public Works Departments throughout the country. They help plan for, run, and oversee waste management and recycling programs in their communities.</p> <p>Environmental Engineers work to develop solutions to environmental problems, including how to improve waste disposal and recycling programs.</p> <p>Sustainability Employee: Though this position may come under different names, it is becoming more and more common for larger companies to have a sustainability department. Employees on this team examine how to integrate sustainability throughout their business's practices and may focus on anything from greenhouse gas emissions to recycling efforts and water management².</p>	<p>Every year, the Earth loses about 18.7 million acres of forests, which is equal to 27 soccer fields every minute. While there are a variety of causes for deforestation, using the trees for commercial purposes such as the manufacturing of paper, homes, and furniture is a common cause.</p> <p>Deforestation has many negative effects. It destroys indigenous homes, animal habitats and entire ecosystems, as well as contributes to climate change around the world. When trees are cut down, they not only stop storing carbon but they actually release it!³</p>

Sources

1. Green Schools Initiative. "Changing Paper Consumption." [Greenschools.net/article.php?ed=75.html](https://www.greenschools.net/article.php?ed=75.html).
2. The Guardian. "Best Practices in Sustainability." <https://www.theguardian.com/sustainable-business/blog/best-practices-sustainability-us-corporations-ceres>.

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- Bradford, Alina. "Deforestation: Facts, Causes & Effects." Live Science. <https://www.livescience.com/27692-deforestation.html>.

BLUEPRINT FOR DISCOVERY

Day 1 (15 minutes)

- Ask students to estimate: About how much paper do you think Americans use every year? Record student guesses on the board. Then share the answer (31.5 million tons) and allow a moment for reactions.
Note: Try to find out how much paper is allocated per student per year in your district and share this data point as well.
- Inform students that 535 million trees are cut down each year to sustain our paper use, and guide the conversation towards the importance of recycling. Tell students that you are going to task them with coming up with a way to recycle and reuse paper within their school.
- Explain that a process has been developed to create homemade paper. It's similar to how larger plants recycle paper, but the end result is not always of the best quality. It will therefore be the students' job to examine how homemade recycled paper is currently made and come up with a way to improve the practice so that the paper can be used in school.
- Distribute the double-sided handout and instruct students to follow along as you demonstrate the steps to creating recycled paper, while making note of ideas or observations that may help them refine the process tomorrow.
- Complete the steps below, being sure to call upon student volunteers for assistance:
 - Fill a bowl with warm water.
 - Show students the scrap paper you have collected and explain that any kind of paper can be recycled. Tear the scrap paper into small pieces and place them in the water. (You should eventually have about two-parts paper, one-part water.)
 - Explain that the paper is soaked in water to break down the paper into fibers. Beat the mixture with a blender or a fork until the paper forms a pulp.
 - Now place the screen into the cake pan. You may need to bend the edges so it fits. Once it is in the pan, pour the pulp into the cake pan on top of the screen.
 - Lift the screen straight up over the pan and allow the screen to drip. When it stops dripping, the screen should be covered in paper pulp. Now place the screen horizontally on a flat surface.
 - Fold paper towels and place them on top of the screen. Carefully blot the pulp with the paper towels so excess water is absorbed.
 - Remove the paper towels and place the screen in a safe place so the paper fibers have a chance to dry overnight.

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6. Explain to your class that you will come back to this paper tomorrow once it has a chance to dry!

Day 2 (25–30 minutes)

Note: Before class begins, place the Day 2 materials in an area easily accessible to students.

1. Divide students into groups of 3-4 and direct them to take out their handouts from Day 1.
2. Direct groups' attention to the screen from the previous class period. Pull the dried paper off the screen and pass it around for student groups to observe. (You may want to cut it into smaller pieces so groups can observe simultaneously.)
3. Encourage the groups to work together to complete Steps 1 and 2 on their handout, which prompts them to think about the papermaking process that they observed and the paper result in front of them. How might they improve the process so that the paper can be more readily used in school? As they brainstorm with their groups, remind them to think outside the box and consider all the places paper is used in their school community. The paper doesn't necessarily have to be used as writing paper!
4. Once Steps 1 and 2 are complete, each group should use the materials available to give their refined idea a try.

Day 3 (10 minutes)

1. Students can begin immediately by examining the result of their dried recycled paper from the day before.
2. Pair groups with each other and encourage them to share their results. Did their plan work as anticipated? What suggestions does the other group have to make it better?
3. With this feedback in mind, student groups should complete Step 3 on their handout: If they were to revise the process one more time, what would they change?

*Note: If you would like to condense this activity into one or two days, you can try to dry the paper pulp with a hair dryer.

TAKE ACTION!

Once students have refined their recycling process enough so it results in a useable product, find a time when students can manufacture more of their paper. Then challenge them to promote use of their paper product throughout your school community!

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Task students with creating a school-wide recycling movement. Their efforts could focus on paper or expand to additional kinds of recycling. Students can put their creativity to good use as they create a campaign that uses targeted messaging to promote recycling.

NATIONAL STANDARDS

<p>Science</p>	<p>Next Generation Science Standards HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.</p> <p>HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems. Technology Education</p>
<p>Technology Education</p>	<p>Standards for Technological Literacy Design Standard 10: Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.</p> <p>The Design World Standard 19: Students will develop an understanding of and be able to select and use manufacturing technologies.</p>

Name: _____ Date: _____

HOMEMADE PAPER RECYCLING STEPS

Directions: Follow along below as you observe the paper recycling process. There is extra space between the steps so you can add your thoughts and observations as you consider how to improve this process.

1. Fill a bowl or bucket with warm water.
2. Tear scrap paper into small pieces. You will want to have about two-parts paper, one-part water. When you have the correct ratio, place the paper into the water.
3. Beat the mixture with a fork or a blender until a pulp is formed.
4. Place the screen into the cake pan. You may need to bend the edges so it fits. Once it is in the pan, pour the pulp into the cake pan on top of the screen.
5. Lift the screen straight up, so it is directly over the pan.
6. Allow the screen to drip over the cake pan. When it stops dripping, place the screen horizontally on a flat surface.
7. Fold paper towels and place them on top of the screen. Carefully blot the pulp with the paper towels so that they absorb excess water.
8. Remove the paper towels and set the screen aside overnight so the paper fibers have a chance to dry.

Paper Recycling Refinements

Step 1: Analyze the Current Solution

Thinking about the paper recycling method that you observed, discuss what worked well and what you would want to change. Remember your goal is to make this recycled paper as user-friendly as possible so it can be used in your school community!

What characteristics of the recycled paper would you like to keep?	What characteristics of the recycled paper might you want to improve or change? Possibilities could include texture, color, weight, strength, shape, etc.

Step 2: Brainstorm and Test Improvements

Choose between one and three characteristics for improvement from above and brainstorm what you could change in the paper-making process to yield these results. Once you have a plan, give it a try!

Improvement:	How can we try to accomplish this?

Step 3: Evaluate the Results

Once the product from your refined paper recycling process is dry, evaluate it. Did the changes you made result in the outcome(s) you expected?

What characteristics of the refined recycled paper would you like to keep?	What still needs improvement? What could be further refined to accomplish this?