



Make Your Own Paper

Activity 51

Students investigate the papermaking process by trying it themselves. Students are thrilled to find that they can make paper and that their product is practical, as well as beautiful. See the PLT website, www.plt.org, to watch a video of the paper-making process used in this activity.

Levels

Grades 1-8

Subjects

Science, Social Studies, Language Arts, Visual Arts

Concepts

- By reducing waste and recycling materials, individuals and societies can extend the value and utility of resources and can promote environmental quality. (2.7)

Skills

Observing, Organizing Information, Comparing and Contrasting



Differentiated Instruction

Higher Order Thinking, Paired/Cooperative Learning, Realia/Hands-on Learning



Technology Connections

Graphics Software

Materials

Scrap paper torn into 1" x 1" (2.5 cm x 2.5 cm) pieces (paper towels, construction paper, and toilet paper work well); a large bowl; a wooden frame 5" x 7" (13 cm x 18 cm) or 8" x 10" (20 cm x 25 cm); nylon or wire screen; staples; a plastic basin at least 2.5 gallons (9.5 liters) in capacity, that is larger than the frame; cloth dish towels (felt, blotting paper, or newspaper may substituted, blender; sponge; strainer; colored paper, pieces of colored thread, or dried flowers (optional) Variation: scraps of construction paper, newspaper, water, blender, 9" x 14" (23 cm x 36 cm) cake pan, 8" x 13" (20 cm x 33 cm) piece of window screening, two 16" x 16" (41 cm x 41 cm) pieces of wood

Time Considerations

Preparation: 30 minutes plus time to gather materials
Activity: two 50-minute periods

Related Activities

Paper Civilization

OBJECTIVE

- Students will describe the steps of the paper-making process and identify the elements and outputs of the process.

ASSESSMENT OPPORTUNITIES

- Ask younger students to write the directions for making paper on the piece of recycled paper that they made.
-  Have students use concept mapping, graphics software, or write a script for a video that explains the papermaking process.

BACKGROUND

Paper is a simple material. It is essentially a mat held together by a fiber's roughness, and can be made from almost any fibrous material such as cotton, hemp, flax, wood or recycled paper. And yet, this simple product has a tremendous effect on our lives. Imagine how different your day would be without paper!

We use paper for countless things in our everyday lives, including newsprint, magazines, schoolbooks, photocopies, computer printers, envelopes, stamps, tissue and sanitary products, bags, boxes, containers, food packaging, gift wrap, wallpaper, disposable dishes, lampshades, and as an art medium. Industrial uses include gaskets, speaker cones, liquid and gas filters, insulation, and friction devices.

The process for making paper was invented in China in the second century A.D., and all paper was made one sheet at a time until 1798. With the Industrial Revolution and the papermaking machine, papermaking became a major industry that provides countless products, from books and newspapers to packaging and note pads. Some modern machines can make a sheet of paper 26 feet (8.8 m) wide and nearly 40 miles (64 km) long in just one hour! While the technology has changed dramatically over the centuries, the basic steps are simple enough for your students to do in class.

The process begins when trees, grown especially for papermaking, are harvested and transported to a paper mill. At the mill, large machines strip away bark and shred the logs into millions of chips the size of breakfast cereal. The wood chips travel on conveyors to gigantic "pulp cookers," where chemicals and steam are added. The mixture is heated and pressurized, breaking the chips into smaller and smaller pieces and finally forming a dilute water suspension of wood fibers called *pulp*. The pulp then passes through cleaners and screens and sometimes goes through a bleaching process that will give it the whiteness needed for the grade of paper being manufactured. Other chemicals such as dyes, pigments, sizings, or resins are sometimes added to provide the paper or paperboard (thick paper for boxes) with the appropriate finish.

The pulp is then pumped through pipes to a paper machine where it is sprayed onto a wide, moving wire screen. After the water in the pulp drains through the holes, a damp mat of wood fibers remains; this is the paper. It is picked up from the end of the moving belt and dried over steam-heated rollers.

Commercial papermaking affects the environment in several ways. The energy needed for papermaking comes primarily from fossil fuels, which are nonrenewable. Burning those fuels can put carbon dioxide and other pollutants in the air. However, for public safety, there are state



and federal guidelines that control emissions. Most of what you see coming out of the mill's smokestacks is steam, not pollutants. Many mills recycle the waste paper they produce, and use wood waste to generate their own electricity for the process.

The wastewater from the papermaking can cause pollution problems. However, in the United States and Canada, the water discharged from mills is tightly monitored and controlled. Traditionally, the pulp-cooking process created strong odors, but most mills now have systems in place to alleviate this issue.

Most paper comes from trees, a renewable resource. Most of the trees used for paper are managed for that purpose. In commercial papermaking, more than half of the fiber comes from lumber mill residues and from paper that has been collected for recycling.

Paper is easily recycled, which helps reduce waste. However, no matter how much paper we recycle, new trees still will be needed for paper products, because paper cannot be recycled indefinitely. Each time paper goes

through the manufacturing process, the fibers deteriorate. After repeated recycling, the fiber is no longer suitable for papermaking.

Producing recycled paper requires about 40% less energy than producing non-recycled paper. And making recycled paper produces 70% less water pollution and much less air pollutants, such as greenhouse gases, particulates, and other hazardous pollutants.

In 2003, the United States, for the first time ever, recycled more than 50% of the paper it consumed. This means that fifty million tons of paper did not end up in the waste stream—equivalent to two hundred and thirty Empire State buildings full each year. In total, recycling paper reduces the amount of solid waste produced in the manufacturing of paper by over 60%.

GETTING READY

 Decide how you will conduct the activity. If you are short on materials or adult supervision, you can demonstrate; but, ideally, you should try to find a way for the stu-

dents to participate. Middle school students might use stations so some students can make paper while others do a different activity. For younger students, you might ask a parent or aide to help at stations, or have an activity for the rest of the class while you help small groups make paper.

The papermaking process is a wet one, so plan to use a work space that won't be harmed by moisture. You might want students to wear "wet gear"—an apron or smock, or old clothing. Remove any plastic or staples from the scrap paper, and tear it into small pieces (1-inch or 2.5-cm squares). Soak the paper in hot water in the large container for at least 30 minutes.

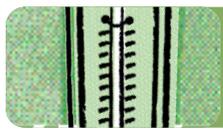
Buy or build a wooden frame, which you will prepare for paper making. Tightly staple or tack nylon or wire screening to the frame, making a "deckle," which is the surface on which you will layer the fibers.

DOING THE ACTIVITY

1. Introduce the activity by asking students what they think paper is made of and how it is made.

 **2.** Fill the blender halfway with warm water, then add a handful of the soaked paper. Blend at medium speed until you no longer see pieces of paper, and the pulp has a soupy consistency. You can blend in a piece of construction paper for color; or stir in short pieces of thread, dried flowers, or herbs for texture.

3. Pour the mixture into the large basin and then fill the basin with warm water, mixing thoroughly until the ingredients are evenly dispersed. Adding a few ounces of liquid starch will help make the paper firm.



4. Slide the deckle into the basin. Put some pulp onto the screen and, still holding the deckle underwater, gently move it back and forth to get an even layer of fibers on the screen.

5. Lift the deckle out of the mixture, keeping it flat. Allow it to drip until most of the water has drained off. You should have a uniform layer of pulp mixture on the deckle. Press the pulp gently with your hand to squeeze out excess moisture (rubber gloves will help). Soak up any excess water from the bottom of the screen with a sponge.

6. Place newspaper on a flat surface and turn the screen paper-side-down on the cloth. Lift the screen gently, leaving the paper. Gently tap the screen to help release the paper.

7. Let it dry naturally for several hours or overnight. Gently peel off the paper when it is dry.

8. When you're finished making paper, collect the leftover pulp in a strainer and recycle it, or freeze it in a plastic bag for future use. Don't pour the pulp down the drain!

 9. Discuss these questions:

- What materials did we use in making paper?
- What forms of energy did you need to make the paper? (electricity and students' own energy)
- What types of wastes resulted from making paper? (dirty water, leftover pulp)
- What did we do with the waste products?
- What were some problems with making paper? (cleaning up the mess)
- What would it be like in a paper mill, where tons of paper are being made a day? Why do you think recycling paper is important? What about reducing the amount of paper you use?
- How is the new paper different from the old paper that you recycled?

Variation—Pictures from Pulp

1. Collect plenty of construction paper scraps and sort them by color, tearing them into dime-sized pieces.

2. Make different colored pulps. For each color, repeat this process: fill the blender half with paper pieces, and half with water. Blend at medium speed until smooth. Pour each color pulp into a separate container.

3. Fill the cake pan halfway with water and submerge the screen.

4. Choose a background color for your picture, and put one-half cup of that color pulp in the cake pan. Mix it so it is evenly dispersed in the water above the screen.

5. Carefully lift the screen out of the water and allow excess water to run off. Your background layer will remain on the screen.

6. With the background pulp on top, place the screen on several sheets of newspaper on one of the boards.

7. Create your picture by carefully dripping thin layers of the other pulps on top of the background pulp. This can be done by pouring the colored pulps into small paper cups and pinching the cup rims to make pouring spouts. Once pulp is dripped onto the screen, do not try to remove it, or you will tear the background pulp and create holes in your picture.

8. When you finish your design, place a few layers of newspaper on top. Put a board on the newspaper, creating a paper press "sandwich." (See diagram on the next page.)

9. Press firmly on the top board to squeeze out moisture.

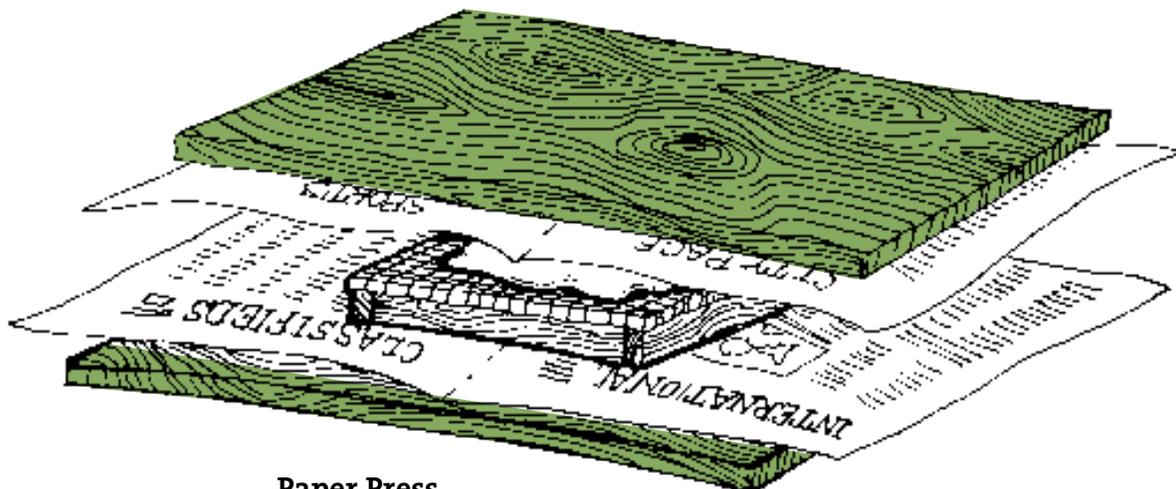
10. Turn the paper press upside down. Take off the board, then the newspaper, and then, very carefully peel the screen away from the paper. This is the back of your picture.

11. Leave your picture face down on the newspaper and put it in a warm, safe place to dry. Once it's dry, carefully peel it off to reveal your work.

Enrichment

- Students can use different types of materials to make paper, and then compare the papers. Students might try newspaper, paper towels, typing paper, or cotton balls. Which paper is the strongest? Which is water resistant? Which is best for writing? What other comparisons can students make? What kinds of uses can they think of for their new paper? What materials can they use that might otherwise be thrown away?
- Students create a book or bulletin board showing different kinds of manufactured paper, and describing the characteristics, benefits, and limitations of each. For example, they might include samples of newsprint, gift wrap, parchment, wallpaper, vapor barrier for houses, packaging, milk cartons, greeting cards, and so on.





Paper Press

- Have students investigate the process used in modern paper factories. Discuss ways it is similar to and different from making paper by hand.
- Students can make paper for the school to be used as class “thank you” notes, graduation invitations and so on. They might also use the paper to write a poem (as in Activity 5, “Poet-Tree”) for Mother’s Day, Father’s Day, or Grandparent’s Day.
- If you live near a paper mill, invite a representative to help your class make paper. Ask him or her to bring samples of wood chips, pulp, and paper, if possible.
- Research to find out what other fibers—in addition to wood fiber—are used to make paper such as hemp, flax, cotton, and rice straw.



READING CONNECTIONS

Curtis, Neil and Peter Greenland. *How Paper is Made*. Lerner. 1992. Describes how paper is made, beginning in a forest and ending in a paper mill. Grades K-3. ISBN: 0822523760.

Diehn, Gwen. *Making Books That Fly, Fold, Wrap, Hide, Pop Up, Twist & Turn*. Sterling Publishing Company, Incorporated. 2006. This book’s projects showcase a host of features and magically unfold like a map, contain cards that slip into pockets, include

pop-ups perfect for celebrating all types of occasions, and tell stories on a scroll. Students will enjoy choosing the style that’s just right for what they want to say and do. Grades 5+. ISBN: 1579903266.

Grummer, Arnold E. *Paper by Kids*. Dillon Press. 1980. Step-by-step instructions for various methods of making decorative paper using materials found around the house and simple equipment that can be bought or constructed. Grades 1+. ISBN: 0875181910.

Marshall, Pam. *From Tree to Paper*. Sundance. 2002. An exciting photo-essay book

explaining how trees are made into paper. This book carefully explains the papermaking process so children understand how changes in matter occur. Grades PreK-2. ISBN: 082250720X.

Woods, Samuel G. *Recycled Paper: From Start to Finish*. Gale Group. 2000. Demonstrates how waste paper is recycled into useful household products at the Marcal paper mill. Grades 2-7. ISBN: 1567113958.

