



Forest Resources and Papermaking

Subject Area: Humanities

Core Curriculum Content Standards: 1.2.D, 3.3.A, 3.4.A, 5.1.A, 5.2.A & B,
5.10. A & B, 6.1.A, 6.6.E

DESCRIPTION: This session is designed to combine learning the techniques of papermaking with utilization and conservation of forest resources in daily life.

OBJECTIVES:

Students will list high points in the history of papermaking.

Students will list humans' uses of paper for: daily life, business operations, communication, and cultural arts.

Students will learn a simple procedure to make one sheet of paper out of recycled newspaper.

Students will consider activities that they enjoy doing, and describe how paper is used for the activity.

Students will briefly study modern papermaking procedures and consider the resulting pollution effects on natural resources.

Students will describe ways to efficiently use paper products.

Students will review survival needs of all wildlife: food, shelter, water, oxygen and space.

Students will compare a mono-culture area (*Piney Point*) with a mixed-culture area (*Wildlife Habitat Area* adjacent to Piney Point), and determine the wildlife diversity at each site.

BACKGROUND INFORMATION

Chronological History of Papermaking

105 A.D. - There are many stories about the origins of paper. One story has it that a man named Ts'ai Lun, who was a servant of the Emperor of China, was washing the emperor's silk robes in a large pot over a hearty fire in the palace courtyard. He found laundry, like most of us, a hugely boring task, and upon seeing a friend passing by went to chat leaving the laundry unattended. Ts'ai Lun talked a long time and belatedly returned to the laundry pot to find he had reduced the emperor's fine silk robes to mush. Knowing that he'd lose his head for sure if he didn't think of something quickly, he raced off to find some help. In his haste, Ts'ai Lun tipped over the pot, spilling the mush all over the stones of the courtyard where it began drying in the sun. Ts'ai Lun later returned to clean up the mess, his heart heavy because he could find no way to replace the emperor's robes. It was then that he discovered something interesting about the mushed up silk robes. Where he had stepped through the mush and pressed it flat, a thin, smooth sheet had formed. This discovery was brought before the emperor. The emperor was impressed and not only let him keep his head, but made it possible for Ts'ai Lun to experiment with other fibrous materials, like rags, old fishing nets, and tree bark. Paper making was a royal secret for approximately 600 years. Other plants used for papermaking included rice, but rice had more use as food for the common people. Also, literacy was a thing for kings, scribes, and holy men, during that time period.

600 – Papermaking travels to Korea. About 15 years later, it reaches Japan.

770 – Earliest instance of text printing upon paper in the Empress Shotoku of Japan's million dharai (prayers) book.

8th century – Moslems invade China and take the knowledge of papermaking to Egypt and Morocco.

circa 1450– The moveable type printing press was invented by Gutenberg.

1690 – The first paper mill is established in the United States in Philadelphia, Pennsylvania.

- 1719 – Rene Antoine Ferchault de Reaumur (1683 – 1757), a French naturalist wrote of his observations of the American paper wasp’s ability to make paper from pulp. It wouldn’t be until the latter part of the 18th century that his observations, and a growing demand for paper, would lead to it being made from wood pulp, instead of what Americans had been using to date, including: flax plant fibers (linen) or cotton. (*See timeline entry for 1801.*)
- 1790 – Chlorine is identified as an element, and in 1838 is used commercially to break down lignin in wood pulp.
- 1799 – Nicholas-Louis Robert, a Frenchman, invented the first papermaking machine. He never collected any money for his invention.
- 1801 – Matthais Koops used wood pulp in his paper mill. He went bankrupt in 2 years.
- 1807 – The Fourdrinier brothers (Henry and Sealy) perfected the papermaking machine. A flaw in their patent allows others to copy their machine. However, the machine that they invented is not only still being used, but still called a Fourdrinier.
- 1851 – The first chemical process used in preparation of wood for papermaking.
- 1857 – Benjamin C. Tilghman developed “sulfite process,” an acid method for preparing wood fiber.
- 1914 – It is estimated that 14,000 different paper products were manufactured.

MATERIALS NEEDED:

This session is usually conducted in Long House proper OR on the Craft Porch section of Long House, which is located on the Sequoya Campus. All equipment needed for this class is located in closets on the Craft Porch.

Before class begins, prepare several loads of shredded newspaper. Follow steps 1 through 4 in the section of this lesson plan titled: MAKING PAPER – Method.

PROCEDURES:

1. During class introduction, ask students to explain what paper is. *A substance typically prepared in thin, flat sheets, made from mechanically and chemically treated fibrous cellulose, usually from wood, rag, etc., and used as a writing and printing surface in packaging, etc. (Websters Dictionary)*
2. Ask students to note 10 activities that they enjoy. List them on dry-erase board or blackboard and have students rank them in order of most favorite to least favorite. Then put an X next to those that need paper.
3. Have students name several activities that we use paper for: A. communication – newspaper, notes, signs, magazines, letters. B. packaging – containers, labels; C. personal – tissues, toilet paper, napkins, diapers; D. money \$\$\$ - stones, sea shells, bartering. E. decorative – wall paper, wrapping paper, origami, matting, photos, etc., art painting.
4. Demonstrate how to make a sheet of paper.
5. Walk to Piney Point and the adjoining *Wildlife Management Area*. Compare plant life and animal life, or indicators of it, at each site.

MAKING PAPER

EQUIPMENT:

blender large tub mold and deckle pieces of felt irons newspaper water

METHOD:

1. Shred paper into pieces approximately the size of your pinky nail (2 cups per person).
2. Place shredded paper in blender with 1 cup of water.
3. Blend on a medium setting until the resulting mash is the consistency of cream of wheat (approximately one minute).
4. Pour into pan containing about 3 inches of water.
5. Submerge the mold, screen side up, with deckle on top of it, in the tray of mash. Slide back and forth, and side to side, until the screen is evenly covered.

6. Remove deckle and let the mold drain over the tray.
7. Place a piece of felt over the mold and turn the mold felt side down on a pile of newspapers.
8. Use a sponge to remove excess water from the back of the mold. Be sure to get the corners.
9. Peel felt and wet piece of paper from the mold.
10. Place another piece of felt over the exposed piece of paper, creating a "paper sandwich."
11. Place felt, wet side up, on a stack of newspapers. Iron on the wet side.
12. After several minutes, the amount of steam should lessen. Have students write their name on a glossy piece of newspaper. Carefully remove partially dried paper and position it on glossy newspaper. Store in a safe place until completely dry.

THE COMMERCIAL PULP AND PAPERMAKING PROCESS

TREES: Delivered to the mill by truck or train.

WOODYARD: Sorted by species and stored in piles. *Only 50% of the tree is useable for papermaking. The bark, leaves, and upper limbs are not used.*

BARKING MACHINE: All bark is removed because it is lower in fiber and more work to process.

CHIPPING MACHINE: Logs are cut into 1/2 – 3/4 inch square and 1/8 inch thick pieces. Pieces that are too large are run through the machine again. Pieces that are too small are combined with the bark and burned in the furnaces. The chips are stored in bins above the digester until needed.

DIGESTER: 40 feet high, 12 feet in diameter, and has a capacity of 10 tons of dry chips. A solution is added to the chip called white liquor (sodium hydroxide and sodium sulfide). The mixture is pressurized to increase the temperature. The mixture is cooked until the cementing material (lignin) between the wood fibers dissolves. It takes @ 2^{1/2} to 5 hours at 330° to 360° F. and pressures up to 100 pounds per square inch.

WASHER: The resulting mash is sent to be washed, in order to separate the pulp from the cooking solution.

RECOVERY SYSTEM: The liquid separated from the pulp is processed to recover all the useful chemicals. Evaporation removes the excess water from the solution. The resulting thick dark liquid can be burned in the furnaces like crude oil to help fuel the papermaking process. During the burning, the sodium salts melt and run off and are recycled back into the digester.

SCREENS: Meanwhile, the wood pulp is being passed over screens to remove any bits of wood that managed to remain uncooked. These uncooked portions are usually knots that are denser than the rest of the tree.

BLEACHING SYSTEM: There are 4 steps in this process: 1. Chlorine gas is passed through the pulp in order to remove any bits of lignin that escaped the cooking process (lignin bonds with chlorine). 2. Sodium hydroxide is added to the pulp/chlorine mixture in order to separate out the chlorine and lignin. 3. The mixture is washed. 4. The pulp is treated with a hypochlorite solution to make it white. Some systems use chlorine dioxide to get paper even whiter. *It has been discovered that the bleaching process is releasing harmful toxins into the environment. The toxins come from chlorine mixing with the lignin. The resulting chemical compound is a dioxin. Dioxin is a term used for 75 compounds that have the same basic structure. Some dioxins that we might recognize are Agent Orange and PCP. The dioxin resulting from the bleaching process is called TCDD (tetrachlorodibenzo-p-dioxin). TCDD and other toxins are carcinogens that scientists believe mimic estrogen. These chemical compounds effect many systems in the body, e.g. the liver and reproductive organs. All bleached products are contaminated by dioxins. Dioxins are fat-soluble, which means they stay in your system (bioaccumulation) and that can lead to the toxin traveling the food chain. Colored paper is created with plastic-based dyes that are non-biodegradable. Pulp mills regularly release contaminated water and dust into the surrounding environment.*

REFINING: The bleached pulp is brushed, rubbed and cut to allow better bonding.

PAPERMAKING MACHINE: Wood pulp is dumped into the "head box." From there, it travels down onto a bronze screen moving at high speeds. Water falls through the screen and suction is also supplied to remove as much of the water as possible (@ 80%). The pulp then moves on to a series of presses where more water is squeezed out, and the pulp is finally dried into paper by a series of steam heaters. Sometimes during the last step, chemicals are added to change the texture or

absorbency of the paper. These machines are called the sizer and the coater. The very last step is called calendaring, which entails rolling and checking for quality in the paper.

WRAP-UP INTERPRETATION

Suggest that when students and teachers return to their school they try two activities:

1. Notice the paper contents of their desks. Suggest that their teacher pass around a scale for them to use to weigh paper. Have one student record and tabulate the average total volume for the class. Multiply by the number of grades attending the school. Discuss how much of this paper could be saved, and volume reduced, if both sides of the sheet were used.
2. Read Dr. Seuss' book titled: The Lorax. Discuss the effects of improperly managed resources.

*I am the Lorax. I speak for the trees.
I speak for the trees, for the trees have no tongues.
And I'm (telling) you...at the top of my lungs-
...UNLESS someone like you
Cares a whole awful lot,
Nothing is going to (change).
It's not.*

The Lorax, by Dr. Seuss

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