PAPER MAKING
LESSON PLAN

WOLF RIDGE℠
ENVIRONMENTAL LEARNING CENTER

PAPER MAKING

CLASS DESCRIPTION: A Creative Expressions Class

Students will learn about the history of paper making and discover the ecological and economic benefits of using recycled paper. Students will go through the process of making four sheets of recycled paper. Artistic creativity is encouraged. After drying overnight the paper will be ready for use the next day.

Total time: 1.5 hours
Audience: 4-20 students, 4th grade through adult
Activity: easy
Travel: none
Total uphill travel: none

PURPOSE

To examine human resource use and impact through the art of paper making.

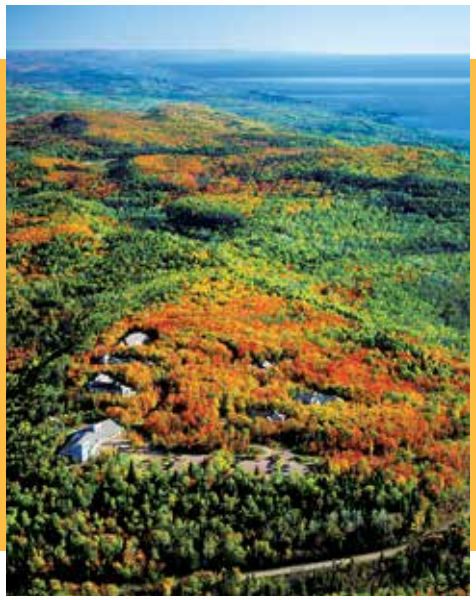
CONCEPTS

1. Humans have a great ability to alter natural systems, and a responsibility to consider the effects of our actions.
2. Awareness, knowledge and appreciation lead to understanding of our impact.
3. Waste and pollution are by-products of human society.
4. Economic and political considerations have an influence on human actions.
5. Using renewable resources is more sustainable than using non-renewable resources.

OUTCOMES

Upon completion of Paper Making students will be able to:

- List materials that can make paper.
- Define renewable and non-renewable resources.
- Describe two ways that our use of paper affects the environment.
- Show how consumer demand influences the paper industry.
- Make recycled paper using a simple process.



PAPER MAKING

Revised April 2024

Equipment

- full lesson plan
- wool fiber container
- 2 scrap paper bins
- 20 paper sorting trays
- 10 deckles
- 10 deckle tubs
- 10 rollers
- 10 felt couches
- 10 measure pitchers
- 2 blender motor bases
- 4 blender pitchers
- paper sample book
- "one pound" ream of paper prop
- paper dryer

Appendices

- Glossary
- References
- Sources

Set-up (15 min.)

- Classroom/class prep description
- Safety Management

I. Introduction (10 min.)

A. Greeting
B. Class Overview
C. Assess Learner Level

II. History of Paper (15 min.)

III. Paper as a Resource (15 min.)

IV. Making Paper (45 min.)

V. Conclusion (5 min.)

A. Review
B. Stewardship Actions

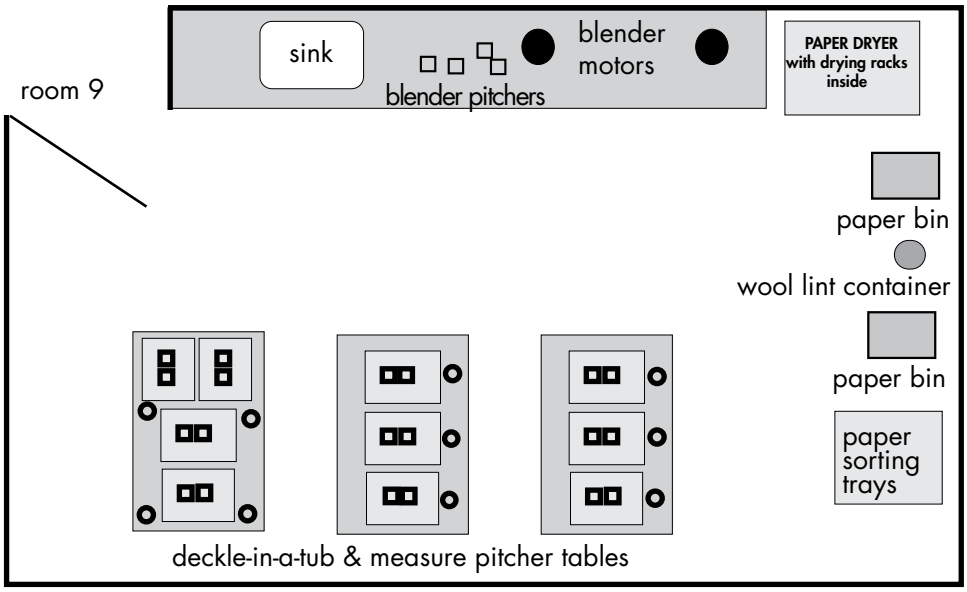
Clean-up (5 min.)

Set-up (10 min.)

Classroom/class prep description

Paper making is a fun and easy activity. The more organized you are in setting up the equipment, the smoother the process will be. Equipment is located in rooms #4 and #9 of the Education Building.

1. Set up scrap paper bins, wool fiber container and paper sorting trays on the floor.
2. Place blenders and pitchers next to the sink, ready to be filled with paper and water.
3. Set up 3 deckle tables and 10 deckle tubs.
4. Place a felt couch and roller in each deckle tub.
5. Drying lettered drying trays are located inside the paper dryer located in each room.



Safety Management

Adhere to and be familiar with all general safety practices designated by Wolf Ridge. Be aware of any student's special needs (medical, etc.) and adjust the activities as needed to maintain safety.

- First aid kit is located in the kit room.

I. Introduction (10 min.)

Grabber

Greet the students as they enter and let them look and wonder about all the equipment set around the room. While they are sitting at the tables, pass around the paper sample book for them to examine.

Overview of the Class and Outcomes

Students will sit tight for the first 20 minutes while aspects of the paper making process are discussed. After a brief demonstration, students will be given 45 minutes to make up to 4 post card sized sheets of paper. The concepts focused upon deal with our use of resources and how we affect the environment by our actions.

Assess Learner Level

During the introduction find out what the students already know about paper and paper making.

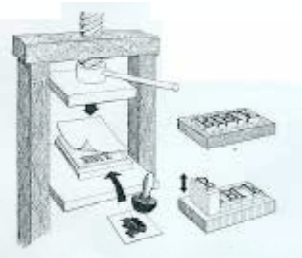
1. *"Has anyone here made paper before?" (Share experiences.)*
2. *"How many of you recycle paper? " (40% of the garbage (solid waste) in Minnesota is paper and paper products).*
3. *"Who knows what paper is made from?" (Modern paper is made from wood fibers of trees. In Minnesota, aspen is most common species harvested for paper and paper products. Stationery and art paper has a certain linen or cotton content, which adds durability, but also cost and resources.)*
4. *What was used for writing before paper? (clay, skins, cliffs, bone, reeds, bark, rags, etc.)*

II. History of Paper (15 min.)

Throughout human's early history many different surfaces were used to record ideas and exchange messages. Ask the students to make a list of primitive (pre-paper) writing surfaces. The list may include cliffs, cave walls, bones and tusks, leaves, bark, cloth, clay, animal skins, etc.

4000 years ago the Egyptians discovered a more efficient writing surface than animal skins. Papyrus, a type of reed, was woven into a mat and then pounded into a hard thin sheet.

2000 years ago paper as we know it today was invented by the Chinese. They mixed up bark, hemp and rags with water, mashed it into a pulp, pressed out the liquid and hung the thin mat to dry in the sun. This mostly wooden mixture launched a revolution in communication. One Chinese emperor had a library of 50,000 books at a time when most of the great leaders in Europe couldn't even write their names.



1000 years ago the conquering Moors brought the Chinese technique for making paper to Europe. The idea of including wood was lost along the way, and paper was made using a mixture of rags and cloth, one sheet at a time, until the early 1800's.

150 years ago a machine was made for grinding wood into fibers and several chemical pulping processes were invented that made tree fiber papermaking an economical, mass-produced operation.

Today the vast bulk of modern paper is now made mostly from the wood fiber from trees. Wood is made of billions of small cellulose fibers, bound together by a glue-like substance called lignin. The sap, resins, lignin and other matter in the tree have to be separated from the cellulose fibers in one of two ways: ground wood pulping or chemical pulping. Ground wood pulping is accomplished by high speed mechanical grinding and rubbing of wood chips between stones or blades. This process makes lower quality papers like newspapers. Chemical pulping produces higher quality papers. The wood chips are fed into giant tanks called digesters. Chemicals are added and the whole mass is steamed to produce pulp and eventually into paper.

In other parts of the world, some paper is made from non-wood sources; from rice and barley straw in China, from sugar cane waste ("bagasse") in Mexico and India, from bamboo in Vietnam, from hemp in Brazil, and from the kenaf plant in Australia.

In the future paper will be made using more alternative sources of fiber and also using more recycled paper fibers. As of 2018 paper pulp is made (on average) from 33% recycled fibers, 33% whole trees and plants, and 33% sawmill residue.(2023) Paper produce recycling has improved significantly in the past 3 decades. It is now the largest share of municipal solid waste recycled.(2023) In 2022 nearly 68% of paper and paper boards products were recycled.(2023)

Plastic has become a common alternative to paper, especially for bags and cartons. Made from oil, plastic is a nonrenewable resource, but if the bags and cartons are used again and again, they have the potential to be an environmentally responsible product.

Assessment Concept 3 *- Waste and pollution are by-products of human society.*

III. Paper as a Resource (15 min.)

Start this discussion with the question: "How much paper do you use?" Hold up the "One Pound" example ream of paper and let the students guess. Then floor them with the answer. In June 2023, the U.S. EPA reported that the average American uses more than 700 pounds of paper every year, the highest paper usage per capita worldwide. In the last 20 years the U.S. has seen 126% growth in paper usage. The U.S. uses 30% of the global supply and makes up 5% of the world population.(2023)

An estimated 4 billion trees are cut worldwide for paper each year.

Wood and paper can be considered natural resources, or raw materials supplied by the earth. Have students list some examples of resources. As you write their answers, put them in two columns for renewable and non-renewable resources. Answers may include:

Renewable Resources	Non-renewable Resources
sun	oil
wind	gold
water	iron
trees & plants	aluminum
animals	coal

The definition of a renewable resource is, "a raw material or energy form that can naturally replenish itself. Conversely, a non-renewable resource is one that once taken from the earth, will not be replenished naturally.

Paper is used, often times just once, then landfilled or burned as waste paper. Until recently, very little has been recycled back into paper or other products. Times are changing. Our paper use has gone up "tree"mendously, and so has the cost of disposing of our waste paper. We recognize the coming possibilities of damaging our forests by harvesting too many trees too quickly. Although trees are considered a renewable resource, forest ecosystems take time to respond to disturbance and regain wood fiber content and their biodiversity. Some forests take over 200 years to "renew", Minnesota's aspen forests take approximately 50 years.

Assessment Concept 5 *- Using renewable resources is more sustainable than using non-renewable resources.*

It takes 17 trees to make one ton of virgin paper. Because of current recycling efforts and people's acceptance of recycled paper it is estimated that over 200 million trees are saved each year. Because it takes less energy to make paper from paper, 64% less energy is used to make recycled paper rather than virgin wood pulp, there is less air pollution (74%), less water used (58%) and less water polluted (35%). Harvesting waste paper in cities creates five times as many jobs as does harvesting the raw material from forests.

When weighing the "friendliness" of paper to the environment, there are 3 considerations; recycled fiber content, paper color and method of whitening, and ink and dyes.

Recycled Fiber Content
If a paper product says the word "recycled" on it that usually means that it contains leftover paper from the paper mill and printing operations. This makes good sense for the paper and printing companies to do this but it doesn't contain paper that has been used by us consumers. We should be looking for the word "post-consumer" on a paper product. Post-consumer means that the paper has been used by a person already and instead of being thrown away it has been collected, sorted, and re-made into another paper product. 100% post consumer means no new trees were cut to make the product. Paper cannot be recycled forever, only up to 12 times. Each time paper is recycled the fibers become shorter and weaker so high grade papers will still need some virgin tree fiber to give strength, but think of the benefits of using post consumer recycled fiber whenever possible!

Paper Color and Method of Whitening
Bleaching paper with chlorine makes beautiful white paper but also releases cancer causing dioxins into the environment. The more natural and duller grays and browns, require much less whitening chemicals. Hydrogen peroxide and sodium hydrosulphite are safer bleaching agents than chlorine bleach compounds.

Dyes and Inks
Neon and bright colored papers use strong dyes that need to be bleached during recycling. Avoid these dyes and you use fewer whitening agents. Many inks are now made using vegetable dyes and are safer than synthetic or metallic inks.


1.


2.


3.


4.


5.


6.

Assessment Concept 3 *- Waste and pollution are by-products of human society.*

As more people recycle their waste paper, it becomes economically practical to use it as a resource. Purchasing post-consumer recycled paper is becoming more and more acceptable and common as we learn about its advantages. Industry has responded dramatically to market and consumer pressures and is now using ever increasing amounts of recycled fiber. ST Paper mill in Duluth, MN produces 100% of its recycled fiber and has the capability to manufacture a product with very high post consumer fiber content. Paper used by the federal government must include 30% post consumer recycled content.

Assessment Concept 4 *- Economic and political considerations have an influence on human actions.*

V. Students Make Paper (45 min.)

Students should be able to make up to 4 sheets of paper which can later be used for notes or postcards. The instructor manages the safety aspect of the blenders, supervise draining of water from the deckle tubs into the sink, and keep general chaos in check. Walk through the paper making process, explaining techniques as you go. Have students:

Step 1: Paper and lint (photos1, 2)

- Get a paper sorting tray.
- Select paper from the paper bins.
- Collect a small, pea-size piece of wool fibers. (These fibers give strength to the paper.)
- Return to chair.
- Rip paper into dime-size pieces on their sorting tray.
- Separate wool fibers in tiny wisps.

Step 2: Fill and blend (photos 3, 4, 5, 6)

- Fill measure blender with ripped up paper to the yellow paper line.
- Fill measure blender with water to the blue water line.
- Pour your measured paper and water into one of the blender pitchers.
- Hold the cover tightly on the blender pitcher, blending to desired consistency (10-30 seconds).
- Tiny pieces of different colors can be added in a second blend of 10 seconds.
- Add wisps of wool fibers and blend twice for 1 second each time.


7.


8.


9.


10.

Step 3: Deckles (photos 7, 8, 9, 10)

- Place a closed deckle, this side up into a dry deckle tub. (When water level gets over an inch deep in the tub then pour some off into the sink.)
- Pour the paper slurry evenly into the deckle. Jiggle the deckle or use your fingers to spread and arrange the slurry.
- Let the slurry drain for a minute.
- Open the deckle and lay a felt (couch) gently on top of your paper and carefully roll out the water. Wring out the couch and repeat.

Step 4: Drying trays (photos 11,12, 13)

- Select a lettered tray from the paper dryer.
- Gently peel away the couch from the paper. Lay paper on drying tray leaving room for 3 more sheets.
- Slide the drying tray into the proper slot in the paper dryer. (Rack "A" goes into slot "A".)
- Repeat step 1-4 for each sheet of paper.

INSTRUCTOR(photo 14)

- Set the timer on the paper dryer for 12 hours and close the door.
- The next morning have the students retrieve their dried paper from the dryer, making sure students take the paper from their lettered tray.

Assessment Concept 2 *- Awareness, knowledge and appreciation lead to understanding of our impact.*

VI. Clean-up (5 min.) (photo 15)

Have students help with the clean-up.

- When the class is done, place the wet couches on an empty drying trays and put into the paper dryer with the paper to dry.
- Thoroughly scrub both sides of the deckle screens with the brushes. This cleans out the little screen holes. Rinse.
- Dump and rinse the deckle tubs.
- Rinse the blender pitchers.
- Dry tables. Pick up bits of paper and lint.
- Wring out classroom towels and hang up to dry.

VII. Conclusion (5 min.)

A. Review

We have looked at how paper is made, how much we use (700 lbs/person/year), and the advantages of buying post-consumer recycled paper. We have gone through a simplified process of paper making using post-consumer recycled paper and wool fibers.

B. Stewardship Actions

At our current rate of paper recycling we are conserving 200 million trees/year. "How can we increase our recycling rate to save even more trees and reduce the amount of paper going into landfills and incinerators?"

- Use more recycle friendly paper products. Less glossy, less bold and neon colors, soybean based rather than metal based inks.
- Understand the labeling of paper products and buy more 100% post-consumer recycled products.
- Let people know how you feel about the look and functionality of 100% post-consumer recycled paper products.
- Reduce your use of paper and paper products.
- Re-use paper products.
- Recycle. Urge and help others to recycle.
- Write on one of your newly made postcards about ways to re-think our paper use to save trees. Give it to a neighbor or relative and tell them about this paper making class.

Assessment Concept 1 *- Humans have a great ability to alter natural systems, and a responsibility to consider the effects of our actions.*


11.


12.


13.

14.


15.

Appendix

Glossary

couch - Pronounced "kootch". A piece of felt or similar water absorbing material used to press out the water from newly made paper. The paper adheres to the couch until dry and is then pulled away for reuse.

deckle - The hand mold used to make paper.

nonrenewable natural resource - Raw materials supplied by the earth that cannot be replaced for a long time if ever.

post-consumer recycled paper - Paper used and discarded by consumers that has been recycled into another product.

pulp - fibrous material prepared from wood, recovered paper, cotton, grasses, etc., by chemical or mechanical processes for use in making paper or cellulose products. Renewable Natural Resource: A naturally occurring raw material or form of energy which has the capacity to replenish itself through ecological cycles and sound management practices.

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- Envision 95% post-consumer toilet paper - Fort Howard Corp., Green Bay, WI 54307
- Envirographic writing paper 50%/20% post-consumer - Badger Paper Mills, Inc.
- 100% post-consumer - Wisconsin Tissue, Menasha, WI 54952 1-800-462-7546