Classroom Paper Recycling

Provided by TryEngineering - www.tryengineering.org

Lesson Focus

Lesson focuses on how engineers and others have developed and improved the manufacturing of recycled paper. Students work in teams to recycle and manufacture their own recycled paper while learning how recycled paper is manufactured on a larger scale in paper facilities. Student teams evaluate current processes for creating paper and develop improvement to the procedure.

Lesson Synopsis

The "Recycled Paper" activity explores both how engineers have created recycling processes that help reduce the amount of original wood pulp needed for paper manufacturing. Students work in teams to develop their own recycled paper, using excess classroom and home paper and plant materials. They evaluate current paper making procedures, engineer improvements to the process and make their own paper. Teams present their system to the class, evaluate their own and other designs, and present their reflections to the class.

Age Levels

8-18.

Objectives

- Learn about recycled paper manufacturing.
- Learn about re-engineering.
- Learn how engineering can help solve society's challenges.
- Learn about teamwork and problem solving.

Anticipated Learner Outcomes

As a result of this activity, students should develop an understanding of:

- paper recycling
- manufacturing processes
- engineering design
- teamwork

Lesson Activities

Students learn about how chemical engineers and others work together to create recycled paper. They work in teams to create their own recycled paper -- improving upon current methods -- compare the process to large scale recycled paper manufacturing, and present reflections to the class.

Resources / Materials

- Teacher Resource Documents (attached)
- Student Resource Sheet (attached)
- Student Worksheet (attached)

Alignment to Curriculum Frameworks

See curriculum alignment sheet at end of lesson.

Internet Connections

- TryEngineering (www.tryengineering.org)
- Georgia Tech Paper Museum (www.ipst.gatech.edu/amp)
- European Recovered Paper Association (www.erpa.info)
- National Science Education Standards (www.nsta.org/publications/nses.aspx)
- ITEA Standards for Technological Literacy (www.iteaconnect.org/TAA)

Recommended Reading

- Making Paper: A Look into the History of an Ancient Craft (ISBN: 978-1558211674)
- The Papermakers Companion (ISBN: 978-1580172004)

Optional Writing Activity

- Write an essay or a paragraph about the impact recycling of paper, metals, or other materials has had on the environment. The essay may take a global or a local perspective.

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For Teachers:
Teacher Resources

◆ Lesson Goal

The "Recycled Paper" activity explores how engineers have created recycling processes that help reduce the amount of original wood pulp needed for paper manufacturing. Students work in teams to develop their own recycled paper, using excess classroom and home paper and plant materials. They evaluate current paper making procedures, engineer improvements to the process and make their own paper. Teams present their system to the class, evaluate their own and other designs, and present their reflections to the class.

◆ Lesson Objectives

- ✦ Learn about recycled paper manufacturing.
- ✦ Learn about re-engineering.
- ✦ Learn how engineering can help solve society's challenges.
- ✦ Learn about teamwork and problem solving.

◆ Materials

- Student Resource Sheets
- Student Worksheets
- Pulp Making Materials: blender, water, sink, small pieces of paper products (students can gather and bring in or set up bin at school for classroom scrap), plastic bin, paper towels, large basin big enough to contain the pulp mixture and to accommodate each team's paper frame design
- Team Materials: wire mesh (at least two pieces about 10 x 25 cm), sink or bin for collecting water, wire, wood poles, tape, paper clips, rolling pin, towels, wooden board, wooden blocks, pencils, fabric pieces, dried herbs, leaves, flowers, seeds, thread, spices, waxed paper, foil, plastic wrap

◆ Procedure

1. Show students the student reference sheets. These may be read in class or provided as reading material for the prior night's homework.
2. To introduce the lesson, consider discussing how much paper is used in your school, whether your community participates in recycling programs, and perhaps also consider the interdisciplinary options for this lesson in working with an art teacher or artist in your area.
3. Have students view the video available at www.paperrecycles.org/school_recycling which shows one way to make paper in the classroom. The video also shows how recycled paper is manufactured in large quantities in factories. Discuss in class the procedure shown, noting that a screen is a good method for shaping paper and also removing liquids.
4. Ask students to gather paper scraps from home or school. These may include colored papers, paper towels, cardboard, old greeting cards, envelopes, etc. Paper should not have been exposed to food, and should be clean. Suggest that students also gather some colored scraps that they may use separately.

For Teachers:
Teacher Resources (continued)

5. Divide your class into teams of 2-3 "engineers." Explain that they need to develop an improved method of turning pulp into paper in the classroom. They should consider that the pulp will need to have all moisture removed and be allowed to dry. But, the shape, color, patterns of their paper may be whatever they design. For example, some students may want to make paper cups, or have a plaid pattern embedded into their resulting product.
6. Teams consider their challenge, develop a drawn plan for building their paper recycler, develop a list of materials to be used, and present their designs to the class. They may adjust their designs after receiving class feedback.
7. Teams next build their recycled paper systems.
8. The teacher, or perhaps a separate team of students, will create a vat of "pulp" for the class to use. This is achieved as follows:
    a. Have students tear all gathered scrap paper into small pieces then soak overnight in a vat of water (use twice as much scrap paper as you expect to end up in recycled paper). A tablespoon of cornstarch will accelerate the dissolving process, but is not required.
    b. Blend wet paper and water (ratio 2 parts water to 1 part paper) in a blender until it reaches the consistency of gravy. Pour pulp into vat (see materials list) and repeat until vat is half full.
9. Students dip their screen frame shape into the vat of pulp and gather a light coating of pulp on the screen.
10. Next, students remove the water from their pulp (pressure is important in the beginning, but paper can be either left to dry outside for a day, or can be accelerated with a hair dryer.
11. Teams remove their recycled paper from their systems and present to the class along with reflections of the experience.

◆ Time Needed

Two to three 45 minute sessions, allowing for 24 hours drying time.

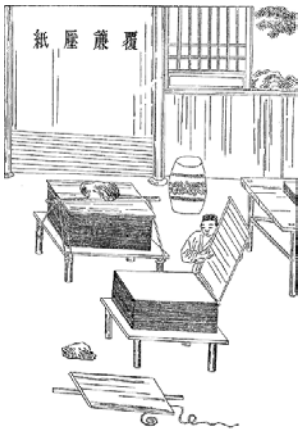
Classroom Paper Recycling

Student Resource: History of Paper

◆ Paper Science and Engineering

Paper engineers combine training in chemical and physical sciences and chemical engineering as applied to pulp and paper processing. They apply mathematics, chemistry, and engineering to the pulp and paper industry, and often focus on recycling efforts.

◆ History



The history of paper began in Ancient Egypt between 3,700 BC – 3,200 BC. They used papyrus for written records, which was a huge improvement over writing on clay tablets. The word "paper" is derived from "papyros," Ancient Greek for the Cyperus papyrus. The Chinese independently developed a papermaking process during the Han Dynasty, between 202 BC and 220 AD, which is where modern paper originated. The illustration to the right shows some of the Chinese papermaking process. The paper used today is primarily made from wood pulp, a process that has been popular for a little over 200 years.

◆ Paper Recycling

Paper recycling is the process of recovering waste paper and remaking it into new paper products. There are three main sources of paper that can be used to make recycled paper. These include: Mill broke (which includes left over paper and trimming from the manufacture of paper), Pre-consumer waste (paper products that were thrown own before they were used by people), and Post-consumer waste (used paper materials such as magazines, newspapers, office trash, old phone books or directories). It is important to recycle these materials as they can be used again and again!

The first step in paper recycling is gathering the waste paper. Next, the paper is shredded and soaked in water or special fluids to break down the paper into fibers. Chemicals are sometimes added to remove ink particles from recycled magazines, newspapers and other printed materials. Next, the pulp is cleaned, often using several methods including heat, chemical, and motion. The pulp is pressed and fluids removed, and the resulting new paper product is dried for reuse. Through recycling, new paper is created from paper that would otherwise have been wasted or dumped in a landfill.

In the mid 1900's paper was almost completely made from new wood pulp. It takes about 3 tons of trees to make one ton of paper if new wood pulp is used. The process also uses a great deal of water. In 2009, the amount of paper recovered for recycling averaged 325 pounds for each man, woman, and child in the United States. However, the United States recycles just about a third of its waste today, which is doubled from what it was a decade ago. In Europe, Austria heads the European Union in its recycling efforts with approximately 60% of its waste being recycled.

Classroom Paper Recycling

Student Worksheet:

◆ Engineering Teamwork and Planning

You are a team of engineers given the challenge of creating a new system for creating recycled paper. When engineers take a fresh look at a product or system and develop improvements, the process is called "re-engineering." Bear in mind that a screen is a very efficient method for both shaping the paper and removing moisture. You review current procedures both for use in classroom and in manufacturing facilities and re-engineer your improved system. You may also incorporate a system for adding color, texture, or designs to your paper -- or come up with a design that uses less water, requires less space, or dries faster. You may add other ingredients to the pulp mixture provided to you including dried herbs, leaves, flowers, seeds, thread, or spices that may add color.

◆ Planning and Design Phase

In the box below (or a separate piece of paper) draw a diagram of your planned recycled paper system, and include a list of materials you plan to use both in the system and in additions to the pulp below.

Materials Required for Building:
Materials to be added to pulp, if any:

Classroom Paper Recycling

Student Worksheet

◆ Classroom Review

Present your plan to your class, gather feedback, answer questions, and determine if you wish to make changes to your original plan.

◆ Construction Phase

1. Build your frame or system for making paper.
2. Test the frame by making recycled paper with the pulp provided by your teacher.
3. Be sure to dry your paper thoroughly before removing from whatever frame you create.

◆ Reflection

1. How similar was your paper recycling system to your written design?

2. If you found you needed to make changes during the construction phase, describe why your team decided to make revisions.

3. Did you add materials to the pulp mixture? If so, did they have the effect in the paper that you intended? How?

4. Do you think this exercise will encourage you to recycle materials? Why?

5. What other materials do you think could be recycled?

6. Do you think that recycling methods have changed over the past twenty years? What technological innovations might have impacted how efficient recycling is today?

7. What impact do you think that engineering has had on recycling around the world?

Classroom Paper Recycling

For Teachers:
Alignment to Curriculum Frameworks

Note: Lesson plans in this series are aligned to one or more of the following sets of standards:

- U.S. Science Education Standards (http://www.nap.edu/catalog.php?record_id=4962)
- U.S. Next Generation Science Standards (http://www.nextgenscience.org/)
- International Technology Education Association's Standards for Technological Literacy (http://www.iteea.org/TAA/PDFs/xstnd.pdf)
- U.S. National Council of Teachers of Mathematics' Principles and Standards for School Mathematics (http://www.nctm.org/standards/content.aspx?id=16909)
- U.S. Common Core State Standards for Mathematics (http://www.corestandards.org/Math)
- Computer Science Teachers Association K-12 Computer Science Standards (http://csta.acm.org/Curriculum/sub/K12Standards.html)

◆National Science Education Standards Grades K-4 (ages 4-9)

CONTENT STANDARD A: Science as Inquiry

As a result of activities, all students should develop

- ✦ Abilities necessary to do scientific inquiry
- ✦ Understanding about scientific inquiry

CONTENT STANDARD B: Physical Science

As a result of the activities, all students should develop an understanding of

- ✦ Properties of objects and materials

CONTENT STANDARD E: Science and Technology

As a result of activities, all students should develop

- ✦ Abilities of technological design

CONTENT STANDARD F: Science in Personal and Social Perspectives

As a result of activities, all students should develop understanding of

- ✦ Types of resources
- ✦ Science and technology in local challenges

CONTENT STANDARD G: History and Nature of Science

As a result of activities, all students should develop understanding of

- ✦ Science as a human endeavor

◆National Science Education Standards Grades 5-8 (ages 10-14)

CONTENT STANDARD A: Science as Inquiry

As a result of activities, all students should develop

- ✦ Abilities necessary to do scientific inquiry
- ✦ Understandings about scientific inquiry

CONTENT STANDARD B: Physical Science

As a result of their activities, all students should develop an understanding of

- ✦ Properties and changes of properties in matter

CONTENT STANDARD E: Science and Technology

As a result of activities in grades 5-8, all students should develop

- ✦ Abilities of technological design
- ✦ Understandings about science and technology

CONTENT STANDARD F: Science in Personal and Social Perspectives

As a result of activities, all students should develop understanding of

- ✦ Populations, resources, and environments
- ✦ Science and technology in society

Classroom Paper Recycling

For Teachers:
Alignment to Curriculum Frameworks (cont.)

◆National Science Education Standards Grades 5-8 (ages 10-14)

CONTENT STANDARD G: History and Nature of Science

As a result of activities, all students should develop understanding of

- Science as a human endeavor
- Nature of science
- History of science

◆National Science Education Standards Grades 9-12 (ages 14-18)

CONTENT STANDARD A: Science as Inquiry

As a result of activities, all students should develop

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

CONTENT STANDARD B: Physical Science

As a result of their activities, all students should develop understanding of

- Structure and properties of matter

CONTENT STANDARD E: Science and Technology

As a result of activities, all students should develop

- Abilities of technological design
- Understandings about science and technology

CONTENT STANDARD F: Science in Personal and Social Perspectives

As a result of activities, all students should develop understanding of

- Natural resources
- Environmental quality
- Natural and human-induced hazards
- Science and technology in local, national, and global challenges

◆Next Generation Science Standards Grades 2-5 (Ages 7-11)

Matter and its Interactions

Students who demonstrate understanding can:

- 2-PS1-2. Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.

Engineering Design

Students who demonstrate understanding can:

- 3-5-ETS1-1.Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
- 3-5-ETS1-2.Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
- 3-5-ETS1-3.Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Classroom Paper Recycling

For Teachers:
Alignment to Curriculum Frameworks (cont.)

◆Next Generation Science Standards Grades 6-8 (Ages 11-14)

Earth and Human Activity

- MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

Engineering Design

Students who demonstrate understanding can:

- MS-ETS1-2 Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

◆Next Generation Science Standards Grades 9-12 (Ages 14-18)

Earth and Human Activity

- HS-ESS3-4. Evaluate or refine a technological solution that reduces impact s of human activities on natural systems.

Engineering Design

Students who demonstrate understanding can:

- 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.

◆Standards for Technological Literacy - All Ages

Technology and Society

- Standard 4: Students will develop an understanding of the cultural, social, economic, and political effects of technology.
- Standard 5: Students will develop an understanding of the effects of technology on the environment.
- Standard 6: Students will develop an understanding of the role of society in the development and use of technology.
- Standard 7: Students will develop an understanding of the influence of technology on history.

Design

- Standard 8: Students will develop an understanding of the attributes of design.
- Standard 9: Students will develop an understanding of engineering design.
- Standard 10: Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

Abilities for a Technological World

- Standard 11: Students will develop abilities to apply the design process.
- Standard 13: Students will develop abilities to assess the impact of products and systems.

The Designed World

- Standard 19: Students will develop an understanding of and be able to select and use manufacturing technologies.