Entangled Engagement with Cellulose Microfibrils:
Hand Papermaking Across Cultures

Details for Laboratory/Class Setup

**Karen C. Hall, Ph.D., Clemson University, Open Science Network for Ethnobiology

Suggestions for use in laboratories and classrooms:

In general, this laboratory is written broadly enough to be used in quite a number of courses including plant biology, ethnobotany, plant physiology, art, cross-cultural, science and technology or other courses as a means of familiarizing students with the process of making paper by hand (process), its uses by different cultures (adaptations), the diversity of plants and processes used in making paper (application/growth of technologies), discovery of how plants make the fiber that we convert into paper and the meaning of paper to cultures and society at large. The focus is hand papermaking rather than paper made through mass production. However, some of the resources listed below could be added to show the transition to mass production and to discuss environmental issues associated with papermaking. Initially, this lab was created to show *diversity of methods/materials/uses by distinct cultures, the *integration of knowledge and methods and the *structure and function of plant cells as they relate to human exploitation for papermaking.

Brief background:

Though many materials have served as surfaces for writing, paper, (dispersed plant fibers), was invented in China during the reign of Emperor Wu, sometime between 140 BC - 86 BC. As papermaking spread across the globe, different cultures have explored many different types of materials and ways of making a paper sheet. Paper has been made from mulberry (kozo), mitsumata (Edgeworthia papyrifera), gampi (Daphne spp.), bamboo, hemp and many, many more plants. Innovations in handmade paper technology include the different ways in fiber is removed from the plant, prepared for sheet formation, tools used in the process, ways in which a paper sheet is formed and the uses and meanings of handmade papers within different cultures.

In this lab, we'll investigate the differences in sheet formation around the globe, practice making paper to understanding the knowledge needed to go from plant to sheet and investigate how plants make the material we exploit for paper. With these ideas in mind, handmade paper is demonstrative of the importance of cultural diversity as a means of connecting to plant materials.

Equipment and supplies:

-Paper samples (cardboard, greeting cards/envelopes, file folder, bookmark, book, foam core, money, handmade paper samples, etc.
-Multiple types of pulp (purchased or have students make, though this takes much more time and more equipment)
-Formation aid
-Inclusions (mica, petals, pressed specimens, dye, etc.)
-Vat (suggest cement mixing tub or rubbermaid container no less than 24 X 36)
-Water
-Moulds/Deckles
-Couching (pronounced cooching) cloths. These can be made from old sheets torn to size
-Laboratory tape and/or clothespins to mark paper owner/maker.
-Sponges and small bowls to accumulate water
-Old towels (assuming you will do inside in a laboratory)
-Powerpoint, LCD projector
-Clip and weights (.5-5g)
-Microscope (could use at front of the lab)

Hypothesis testing:

Diversity in paper sheet formation exists to address different needs of paper in use by different cultures. Consider hypotheses testing the strength of different fibers (easily accomplished using varying weights on a clip and attaching

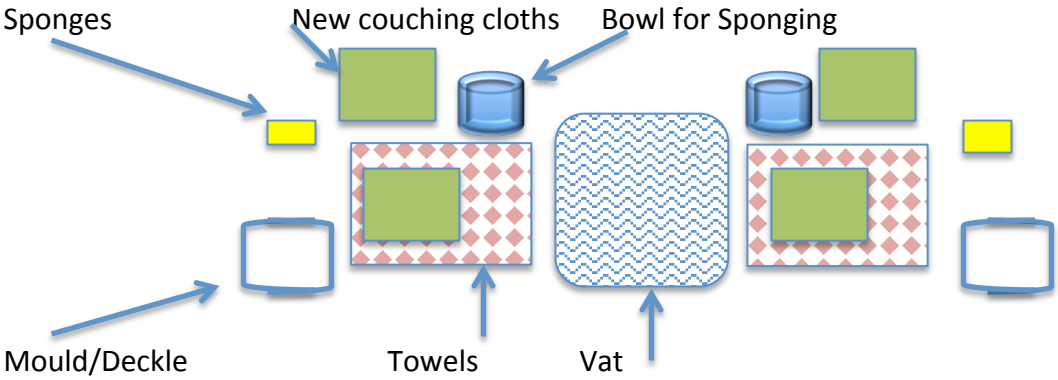
those to different types of paper), ability of ink to adhere (this is based on the addition of sizing to paper sheets, but could be examined under a microscope and quantified), and others.

Qualitative analyses:

If you have a fair number of paper samples, a simple chart of qualitative properties can be developed and used by students assessing differences/similarities between papers. This is similar to what vinters might use to develop the 'nose' of wine tasters. This could be extended to include wet pulp, too. I highly recommend having students make sheets from more than one type of pulp, particularly across categories (bast and leaf, for instance).

Lab setup and helpful hints:

Set up wet and dry areas of the laboratory, with the wet side being used for vats with paper pulp and drying of paper sheets as they are formed. Use the dry side for paper sample display and testing. A recommended set up for the vat on the wet side of the lab is below. Setting up this way allows use of the vat from two sides. An alternative is to have the vat used from both sides of a table, provided it is narrow enough to accommodate. Simply repeat for additional pulps or multiple vats of the same pulp to accommodate larger numbers of students (over 20). Keep a stack of couching cloths above the area with towel. Couching cloths that are to be used to make a single sheet of paper are place on top of the towel to absorb some of the water coming out of the mould/deckle once removed from the vat. Sponges help remove water from the back end of the mould. Once most of the moisture has been wrung out, couching cloths with the wet paper sheet on top can be dried on a flat surface in the sun or on lab tables.



See the URL below for my Papersheet formation for Teachers sheet on how to prepare the fiber for class. Prep from either pulp sheets or plain paper (recycling) is the fastest way to prep for the laboratory. For those interested in exposing students to more of the process, use my Papersheet formation for Artists (below). Obviously, this takes much more time and is not recommended for short 3-4 hour laboratories. Creating enough fiber from plants for a class to use will likely take more than a full day.

Written instructions on how to make a sheet of paper are also found on the Papersheet formation for Teachers pdf. You can also find lots of visual examples on the web, including my own videos at the SEEthnobotany YouTube channel. As sheets are formed, I recommend a the use of laboratory tape or a clothespin for marking each students' sheet as her own. Sheets can be stacked one upon another until the end of the class. Sheets can then be spread out on top of tables or another spot to dry overnight. Wet sheets are incredibly unstable and will not survive transport well until dried. Removing the sheet from the couching cloth once dried is accomplished by gently pulling diagonally opposite ends of the cloth.

Resources:

Hall, K.C. 2012. Chaotic Gardening website: Links for Papermaking. http://www.chaoticgardening.com/relevant-stem-/a-fiber-runs-through-it/links-for-papermaking.html

-Papersheet formation for Artists. http://www.chaoticgardening.com/relevant-stem-/a-fiber-runs-through-it/flowchart_for_papermaking12.pdf

-Papersheet formation for Teachers. http://www.chaoticgardening.com/relevant-stem-/a-fiber-runs-through-it/papersheet_flowchart_k-12.pdf

*Core concept tied to "Ethnobiology Guidelines from the Open Science Network", developed from the "Vision and Change in Undergraduate Biological Sciences Education" (Brewer, et al., 2010).

**Karen C. Hall, Ph.D., carlson@clemson.edu, carlson@me.com, 864-940-7747, 261 Lehotsky Hall, Clemson, SC 29634