THE CASE OF THE STRONGEST CORD

Why was cordage valuable in old Hawaiʻi, and what properties make cordage strong and flexible?

HAWAIʻI DOE STANDARD BENCHMARKS

Science 1: The Scientific Process: SCIENTIFIC INVESTIGATION

- **SC.4.1.1** Describe a testable hypothesis and an experimental procedure.

Math 4: Measurement: FLUENCY WITH MEASUREMENT

- **MA.4.4.1** Explain the need to use standard units for measuring.

Social Studies 3: History: PRE-CONTACT HAWAIʻI HISTORY

- **SS.4.3.2** Explain the history of Hawaiʻi's early economy.

Nā Honua Mauli Ola

- **NHMO: 8-4** Apply the cultural and traditional knowledge of the past to the present.

KEY CONCEPTS

- Hawaiians depended on plants and other natural resources in the *ahupuaʻa* for living and survival.
- Strong cordage was made by twisting plant fibers together, and specific plants were used for their strength, stretch and "non-slip" qualities.

ACTIVITY AT A GLANCE

Students discover the value of cordage in old Hawaiʻi. They make cordage from a variety of plant fibers, form hypotheses, and design experiments to test the strength and flexibility of various types of cordage.

ASSESSMENT

Students:

- "Manufacture" cordage by twisting, and/or braiding natural fibers.
- Form hypotheses and design and carry out experiments to test the strength and flexibility of cordage.
- Explain how standard units of measuring were important when testing the strength and flexibility of different cordage.
- Describe a typical day in the economic life of a Hawaiian in the *ahupuaʻa* system, including a reflection on the value of cordage in old Hawaiʻi.

TIME

7 - 8 class periods

SKILLS

following directions, conducting investigations, measuring, twisting and braiding plant fibers to make cordage, using scientific methods, predicting outcomes, collaborating in a cooperative group

MATERIALS

Provided:

- ✓ cordage research stations handout
- ✓ student reading
- ✓ cordage testing handout
- ✓ Learning Logs 3 and 4
- ✓ cordage-making instruction sheets

Needed for research:

- ✓ reference books on early Hawaiian life (see Resources at end of this lesson)
- ✓ index cards (for students to take notes from readings)
- ✓ Post-it® Notes (for students to flag illustrations of cordage examples)

Needed for cordage science investigations:

- ✓ raffia (for each student)
- ✓ a variety of plant fibers (coconut husks, *hau* bark, grasses and *ti* leaves)
- ✓ a variety of weights (such as dumbbell and barbell weights, rocks, books, bags of rice, bags of sand)
- ✓ a heavy-duty spring scale (30 kg), triple beam scale, bathroom scale or other scales for measuring weight
- ✓ bucket with a strong handle
- ✓ dowel (such as broom stick, to hang spring scale and weighted bucket from)
- ✓ extra string or twine
- ✓ rulers
- ✓ sandpaper

ADVANCE PREPARATION

- ☐ Make a copy of the cordage research stations handout for each student (optional).
- ☐ Make a copy of the student reading and the Learning Log sheets for each student.
- ☐ Make a few copies of the cordage-making instructions to share with students.
- ☐ Gather resource books on life in old Hawaiʻi, especially with illustrations showing different ways that cordage was used (fish hooks, fish line, fish nets, houses, canoes, weapons, musical instruments, games, feather work, basketry, and tools such as the adze).
- ☐ Purchase a bag of raffia.
- ☐ Gather a variety of plant fibers (coconut husks, *hau* branches, grasses, *ti* leaves).
- ☐ Assemble materials needed to test the strength and flexibility of cordage—a variety of weights, scales for measuring weight, buckets with strong handles, rulers, and extra string or twine.
- ☐ See Teaching Suggestion 5 for advance preparation of fibers.

VOCABULARY

ʻaha – sennit or cord braided from coconut husk fibers

cordage – string, rope and twine made from natural plant fibers; cordage was a valuable trade item in old Hawaiʻi

economy – activities related to the production and distribution of goods and services in a particular geographic region

hau – an important plant in Hawaiʻi; plant of the hibiscus family. Cordage made from the inner bark was used to carry water gourds, tie sandals on the feet, sew *kapa* (bark cloth) bed sheets together, fasten the covers of *lau hala* (pandanus leaf) baskets, and bundle rolls of *kapa* or *lau hala*.

niu – the coconut tree. Fibers from the coconut husks were twisted into strong

sennit called ʻ*aha*. Some of the uses of ʻ*aha* were as lashing in canoe-building, net-making for calabashes and to fasten the handle to an adze.

olonā – the inner bark of this small Hawaiian tree provided the strongest cordage in Hawaiʻi used for fish lines and fish nets and nets for feather capes and feather images.

tensile – capable of being stretched

ply – a strand or layer of material

technology – the ways in which people use natural resources for their needs and wants

Teacher Background Information

Background information is provided in the student reading that accompanies this lesson. Excellent information about cordage in old Hawaiʻi is available in the Resources suggested at the end of this lesson, especially, *Lāʻau Hawaiʻi: Traditional Hawaiian Uses of Plants* by Dr. Isabella Abbott.

Teaching Suggestions

1. **Show students how to research Hawaiian cordage. Distribute the cordage research stations handout to each student if you set up stations (optional).**
   - Challenge students to use resource books, magazines and computers to find examples of how cordage was used in old Hawaiʻi.
   - Distribute index cards for note-taking and teach students how to cite their source and take notes. Require students to complete up to four index cards with a different cordage example on each card. (Refer students to the sample note cards shown on the cordage research stations handout.)
   - Alternatively, provide small groups with a large piece of chart paper and colored markers, and have students record their discoveries through illustrations and/or webs.
   - Collaborate with your school librarian!

2. **Share and summarize what students discovered about cordage in old Hawaiʻi.**
   - Have students conduct small group discussions of their findings, or share their discoveries with the whole class.
   - Students could tape their index cards onto the wall in different categories.
   - If students have worked on large pieces of chart paper, post these on the wall and have a spokesperson from each group share their "poster."
   - Summarize what students have discovered in a large class discussion, and/or by having individual students write a brief reflection about what they've learned.

3. **Send students on a cordage "scavenger hunt" and assign student reading.**
   - Instruct pairs or small groups of students to find one sample of modern-day cordage on the school campus (such as thread, string, twine, yarn, rope, fishing line) and bring it back to class. Students may do this at recess by visiting different classrooms and asking teachers for a small sample. Alternatively, ask students to bring samples from home.
   - Add an exercise on measurement by requiring that all samples be 12 inches long (or any other length you choose).

4. **Display cordage samples and plant fibers, and discuss the student reading.**
   <u>Discussion Questions</u>
   - How is cordage made? What differences can we observe in modern-day cordage?
   - How was cordage made in old Hawaiʻi?
   - Direct students' attention to sections on making cordage in the student reading. Instruct students to identify methods of preparing *niu* (coconut) and *hau* fibers for cordage-making. (Both need to be soaked in water for at least a couple of weeks.)

5. **Prepare raw fibers of *niu* (coconut) and *hau* for cordage-making.**
   - Demonstrate how to peel the bark off of *hau* branches (using an *ʻopihi* shell, nail or knife). Invite students to try peeling the bark themselves using shell or fingernails.
   - Let students try separating individual *niu* fibers from the husk.
   - Soak *niu* and *hau* in buckets of cold water for two to three weeks. Change water daily to prevent the fibers from rotting.
   - You may want students to take *niu* and *hau* fibers home to soak in water, or you may want to soak fibers a couple weeks in advance so that students can get right to cordage-making.

6. **Make cordage! Refer to the Student Cordage-making Instruction Sheet provided with this lesson, or let students explore their own techniques.**
   - Give each student a single strand of raffia and let students try to break it. Ask if they would want to sail in a canoe lashed together with raffia? How could they make stronger cordage from raffia?
   - Use raffia to practice cordage-making techniques.
   - Challenge students to test the strength of their cordage through pulling contests!
   - Challenge students to make their own cordage from *niu*, *hau* or other natural materials such as grasses, sedges, vines and *ti* leaf.
   - Discuss why it is important to soak, pound, separate and dry fibers for cordage-making.

7. **Introduce the cordage science investigation.**
   - Challenge students to think of factors affecting the usefulness of cordage for a variety of tasks in old Hawai'i (for example, net fishing, line fishing, canoe-building, hauling logs, house construction, lashing tools and weapons).
   - Lead students to identifying the following factors: breaking point (tensile strength), knot strength, stretch, abrasion resistance and water resistance. All of these can be tested with simple experiments in class.
   - Display the pieces of cordage that students made, and ask students to think of questions they would like to answer or problems they would like to solve using the hand-made cordage.

     Some examples of problem questions: What I wonder...
     - Which is stronger, 2-ply *hau* cordage or 2-ply *niu* cordage?
     - What is the difference in breaking point between twisted cordage and braided cordage?
     - How much does cordage made from coconut fiber stretch? How does it compare to the stretch of *hau* fiber?
     - Which is more abrasion-resistant, *hau* or *niu* cordage?

8. **Distribute Learning Log 3 and review scientific procedures.**
   - Show students how to write a testable hypothesis.

9. **Challenge students to devise methods of testing cordage (breaking point, knot strength, stretch, abrasion-resistance).**
   - Display all of the materials that students could use in cordage science investigations. (See Materials list.) Encourage students to devise their own testing methods using standard weights and measures.
   - Assign the student reading, "How to Test Cordage". This will give students more guidance in devising cordage-testing devices.
   - Discuss why it is important to use standard units of measurement when testing cordage.

Simple Cordage Testing Methods

- Hang weights to finished cordage. Gradually add more weight until the cordage breaks and record how much weight it held before breaking. NOTE: Cordage is strong and will hold substantial weight! Use a heavy-duty/30-kg spring scale, bucket with a strong handle, and weights from a weight set! Use cordage to hang the bucket from the spring scale. Add weights into the bucket until the cordage breaks. Alternatively, add objects into the pail and weigh the pail on a bathroom scale at cordage breaking point. **Be sure to have students keep their feet away from the area where the bucket will fall!**

- Test the stretch of cordage by measuring the length of cordage before and after hanging weights from it. Try this with both wet and dry cordage pieces.
- Hang a heavy weight to a piece of cordage and drop the weight from a specified height. Repeat the drop test until the cordage breaks, record the weight and number of falls.
- Test for abrasion resistance by hanging a weighted piece of cordage over a rough edge (e.g., sandpaper) and passing the cordage back and forth over the rough surface. Record weight and the number of times you can pull the cordage back and forth before breaking.
- Test knot strength by hanging weights from pieces of cordage knotted together.

10. **Allow students time to design and carry out their experiments, and to complete Learning Log 3. You may want to assign a final science report or display.**
    - Group students into science investigation teams of 3 to 4 students per team. Instruct students to design and carry out their cordage science investigations.
    - Show students how to record data using a data chart. Display a sample data chart on a large piece of chart paper posted in the room.
    - Assess students' ability to create and/or describe a testable hypothesis and an experimental procedure to test it.
    - Also assess how students describe the need to use standard units of measurement.

11. **Summarize what students have learned in this cordage activity, and have students complete Learning Log 4.**

References

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Thorne – Ferrel, Rebecca A. Not Dated. Idaho Museum of Natural History Education Resource Center, Cordage Discovery Box. Retrieved November 1, 2006, from http://imnh.isu.edu/Public/JustForKids/CordageDiscoveryBox/SubMenu_4/content_4A_FingerMethod_temp.htm (The usage of the information and images is solely restricted to those non-profit educational materials in support of the *Project Aloha ʻĀina* educational materials, and not for any other purposes.)

RESOURCES

Books with Illustrations and Photos Showing How Hawaiians Used Cordage:

Abbott, Isabella Aiona. 1992. *Lāʻau Hawaiʻi: Traditional Hawaiian Uses of Plants*. Bishop Museum Press. Honolulu, HI.

Buck, Peter. 2003. *The Arts and Crafts of Hawaiʻi*. Bishop Museum Press. Honolulu, HI.

Dunford, Betty. 1980. *The Hawaiians of Old*. The Bess Press. Honolulu, HI.

Hazama, Dorothy. 1974. *The Ancient Hawaiians: Who Were They? How Did They Live?* Hogarth Press-Hawaii, Inc. Honolulu, HI.

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Kidder, Norm. © 1998 - 2007. PrimitiveWays. *Making Cordage by Hand*. The Bulletin of Primitive Technology (Fall, 1996: No.12). Retrieved June 15, 2005 from, http://www.primitiveways.com/cordage.html

Pukui, Mary Kawena and Samuel H. Elbert. 1986. *Hawaiian Dictionary*. Revised and Enlarged Edition. University of Hawaiʻi Press. Honolulu, HI.

Titcomb, Margaret. 1974. *The Ancient Hawaiians: How They Clothed Themselves*. Hogarth Press - Hawaii, Inc. Honolulu, HI.

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