DAT’S HAU!

TESTING TENSILE STRENGTH OF CORDAGE MADE FROM NATIVE FIBERS

BY MEGAN LEARNED

How can we create the strongest cordage?

MIDDLE SCHOOL SEVENTH-EIGHTH GRADE

TIMEFRAME FIVE 65-MINUTE PERIODS

STANDARD BENCHMARKS AND VALUES

COMMON CORE MATH STANDARDS:

- CCSS.MATH.CONTENT.8.SP.A.1 - Construct and interpret scatter plots for bivariate measurement data to investigate patterns of association between two quantities. Describe patterns such as clustering, outliers, positive or negative association, linear association, and nonlinear association.

- CCSS.MATH.CONTENT.8.SP.A.2 - Know that straight lines are widely used to model relationships between two quantitative variables. For scatter plots that suggest a linear association, informally fit a straight line, and informally assess the model fit by judging the closeness of the data points to the line.

- CCSS.MATH.CONTENT.8.SP.A.3 - Use the equation of a linear model to solve problems in the context of bivariate measurement data, interpreting the slope and intercept. For example, in a linear model for a biology experiment, interpret a slope of 1.5 cm/hr as meaning that an additional hour of sunlight each day is associated with an additional 1.5 cm in mature plant height.

- CCSS.MATH.CONTENT.8.SP.A.4 - Understand that patterns of association can also be seen in bivariate categorical data by displaying frequencies and relative frequencies in a two-way table. Construct and interpret a two-way table summarizing data on two categorical variables collected from the same subjects. Use relative frequencies calculated for rows or columns to describe possible association between the two variables. For example, collect data from students in your class on whether or not they have a curfew on school nights and whether or not they have assigned chores at home. Is there evidence that those who have a curfew also tend to have chores?

NGSS ENGINEERING DESIGN

- MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

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

- MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

- MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.
ENDURING UNDERSTANDING:
- Native plants provide valuable resources.
- Using ancestral knowledge we can learn how natural resources are assets to the community.

CRITICAL SKILLS AND CONCEPTS:
- SWBAT (student will be able to) use the scientific method to answer the essential question.
- SWBAT design an experiment to determine how to create the strongest cordage.
- SWBAT identify independent, dependent, and controlled variables.
- SWBAT create tests with repeated trials.
- SWBAT compare the strength of different cordage.
- SWBAT collect data in a two-way table and use relative frequencies calculated for rows or columns to describe possible association between the two variables.
- SWBAT construct and interpret scatter plots for bivariate measurement data.

AUTHENTIC PERFORMANCE TASK/AUDIENCE:
- Students will identify variables that may affect the strength of cordage (i.e.: type of fiber, braided vs. twisted, number of strands used, length of fibers, diameter of fibers, synthetic vs. natural fiber, etc.)
  NOTE: In order to align with math standards, students will need to choose quantitative variables.
- Students will design ways to test, measure and compare the strength of their cordage with each other.
- Students will work together to create several hau cordage strands that are 3-4 feet in length to give to voyaging canoes for use as makana (gifts) on the World Wide Voyage.
- Students will teach 5th and 6th grades how to make cordage (time permitting)

OTHER EVIDENCE:
Lab write-up using all steps of the scientific method, cordage
LEARNING PLAN

Prior knowledge required: Steps of the scientific method, understanding of variables, graphing.

1. Engage: Presentation on cordage, including different wrapping techniques, from local expert (Gary Eoff). (Day 1)

   **NOTE: Save the cordage from this day to be used in lab.

2. Explore:

   a. Define tensile strength: the resistance of a material to breaking under tension (Day 2)

   b. Identify what independent variable student would like to test. (Day 2)

   c. Identify dependent variable (measure) and controls. (Day 2)

   d. Create a hypothesis, materials list, procedure, and data table. Be sure to include repeated trials. (Day 2)

   e. Make cordage in class using various fibers that have already been prepared by the teacher or community member (see resource section).

      Can use Native Hawaiian fibers (hau, niu, ‘ie’ie, wauke, olona, as well as raffia – a palm fiber native to Africa, which can easily be purchased in stores.) (Day 2)

   f. Design a method for strength testing. Students can create their own ways to measure strength. If needed/desire, teacher will have a 110 lb. spring scale (can be purchased for under $20 at WalMart in sporting goods section) that can be used to measure how many pounds of pressure the cordage can with stand. (Day 3)

   g. Commence testing and record data, using a two-way table. (Days 3-4)
3. Explain and Evaluate (Day 5)
   a. Analyze and graph data, creating a scatterplot for bivariate measurement data, when appropriate (ie: number of strands vs. tensile strength)
   b. Write a lab conclusion
   c. Share results with classmates

4. Elaborate: (time permitting) (Day 5)
   a. Create several strands of cordage each 3-4 feet in length to give to voyaging canoes for use as makana.
   b. Teach 5th and 6th grade classes how to make cordage

5. Extend:
   a. Using objects of known mass, measure the elasticity of the cordage (how much it stretches) and evaluate the quantitative relationship between force (mass) and elasticity (stretch) to better understand Hooke’s Law.
   b. Go through the entire process of creating hau cordage (stripping bark, soaking, drying). Test different preparation methods to determine the effect on tensile strength.

REFERENCES/RESOURCES:
Gary Eoff, Local Cordage Expert
http://www.canoeplants.com/index.html
http://pvs.kcc.hawaii.edu/ike/kalai_waa/plants_and_tools.html
http://www.materia.coppe.ufrj.br/sarra/artigos/artigo11415
http://www.physicsclassroom.com/class/waves/Lesson-0/
  Motion-of-a-Mass-on-a-Spring
SAMPLE LAB REPORT

INDEPENDENT VARIABLE
(What is being changed/tested):

DEPENDENT VARIABLE
(What is being measured):

CONTROLS
(What stays the same for each trial)?

QUESTION: (Include both the independent and dependent variables)

HYPOTHESIS:
If ___________________ then, ___________________ will happen, because ___________________.

MATERIALS:
• Pencil
• Lab notebook

PROCEDURE:
1. ___________________
2. ___________________

DATA TABLE: (How many trials for each test are you conducting?):

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AVERAGE

GRAPH(S):
• Scatterplot, Pie, Bar – which ones are most appropriate for your data?
• Graphs are to be drawn with a ruler or made on a computer, titled, axes labeled, and key if needed.
ANALYSIS SECTION (State and explain the results)

STATE AND ANALYZE OR EXPLAIN EACH RESULT

- Write one paragraph for each main result you explain
- Use the right resources to explain the results. Use the background information of the lab, notes taken in class, answers to the lab questions and your textbook.

FOR EXAMPLE: All cokes with sugar sank because their density was greater than 1.0 g/ml. All cokes with nutra-sweet floated because their density was less than 1.0 g/ml. There is a greater mass of sugar needed to sweeten cokes than the mass of nutra-sweet. Therefore cokes with sugar had a greater mass in the same amount of volume as the cokes with nutra-sweet. More mass in the same volume results in a greater density. Since the density of water is 1.0 g/ml and all cokes with sugar had a density greater than 1.0 g/ml they sank in water (continue with additional paragraph to explain why caffeine had no effect).

CONCLUSION SECTION

SUMMARIZE WHAT YOU LEARNED

- Restate in a few sentences the main results and your explanation of the results.
- Explain any errors in your data. If there were any errors hypothesize about what might have caused them.
- Hypothesis correct or not? A simple statement of fact.
- What did you learn from this lab or what additional question would you want to investigate further? Make a statement about what you discovered or what additional experiment would you like to do to answer a related question.