YOU ARE THE TECHNOLOGY:

NAVIGATING

THE WORLD AROUND YOU WITH HAND CALIBRATION

BY BRIDGET BURGER

How are ancient Polynesian navigation techniques of hand calibration useful in the modern world?

HIGH SCHOOL  ELEVENTH AND TWELFTH GRADE

TIMEFRAME  TWO CLASS PERIODS (45 MIN. EACH)

STANDARD BENCHMARKS AND VALUES

Students will be introduced to and practice:

CCSS.MATH.PRACTICE.MP5  Use appropriate tools strategically.

MA.T.4.1  Understand attributes, units, and systems of units in measurement; and develop and use techniques, tools, and formulas for measuring

MA.T. 5.5  Find the value of any trigonometric function and inverse trigonometric function, and solve trigonometric equations
ENDURING UNDERSTANDINGS
Students will be able to:
• understand modern uses of an ancient navigation technique
• apply a learned technique in new situations

CRITICAL SKILLS AND CONCEPTS:
• Polynesian celestial navigation hand measurements
• Trigonometric identities

AUTHENTIC PERFORMANCE TASK:
Students will use ancient Polynesian celestial navigation hand measurements in combination with modern research methods and trigonometric identities to measure the height of a visible distant object, such as a mountain range, or island. Accuracy will be determined upon comparison to actual height.

AUTHENTIC AUDIENCE:
Students in class and teacher/facilitator.

LEARNING PLAN
1. Introduce students to celestial navigation through short videos on Never Lost website.
2. Hand out Hawaiian Star Compass by Nainoa Thompson
3. Have students construct a Unit Circle on the board.
4. Discuss the similarities and differences between the star compass and unit circle.
5. Introduce the concept of celestial navigation by dividing the star compass into equivalent houses, and calculate the degrees of each house. Explain how this knowledge is used in combination with movements of the stars to determine position and direction at sea.
6. Using tape, a ruler, and a marker, instruct students to measure specific marks on a wall (3.5 cm, 17.5 cm, 35.3 cm and 72.8 cm) and one at eye level, and another marker on the floor two meters away from
7. Demonstrate the various types of hand measurements—one finger, two finger, fist, shaka, etc. Have students stand at the tape mark on the floor, and looking toward the wall with arm outstretched at eye level, use various hand measurements to fit exactly between the eye level mark and each of the four marks on the wall.

8. Have students create a small booklet (they can decorate the covers) with each hand part that corresponds to each measurement drawn out on one page. The booklets provide a personalized, artistic outlet for the students to keep a record of their hand measurements. Results may vary as each student’s hand is different.

9. Draw on a white board or other display the triangle formed by the marks placed on the wall, and the floor mark at a distance of 2 m from the eye level mark.

10. Using metric conversions, convert the measurements to equal units, and using trigonometric ratios, determine the angle formed by each triangle at eye level. Answers are: 1 degree, 5 degrees, 10 degrees, and 20 degrees.

11. Then have students label their hand measurement to each corresponding degree in their booklets.

12. Explain to students that we are going to go outside to measure some objects using our hand measurement. Have a student pace off the distance between the wall and 2 meters. Begin with a tree that would be too tall to measure with a measuring tape. Have students stand a considerable distance away, and using their known hand measurements find the hand measurement that best describes the angle to the top of the tree from eye level. Have the student pace the distance to the tree, and then go back inside to calculate the height of the tree using trig ratios. Check for reasonableness. Assign homework to utilize the method with something in their own home or neighborhood environment.

13. Begin the next class with a review of the method and have students share their discoveries with the class.
14. Then go outside and have students use hand measurements to get an angle reading on Kaho'olawe and the peak of Haleakala. Compare findings, and have students re-measure for accuracy. Go back inside and give students the assignment to determine the height of the landforms. Discuss potential methods for determining the distance from the school to the direct locations.

15. Give class time to research and determine the direct distance. Students can compare results in small group setting.


17. Extension: Lead a discussion with students around the question: What are the pros and cons of each method—ancient hand calibration and modern instrumentation?

**GRADING RUBRIC**

<table>
<thead>
<tr>
<th></th>
<th>Unacceptable (1)</th>
<th>Acceptable/Good (2)</th>
<th>Great work (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Using appropriate tools strategically</strong></td>
<td>Student has not used the hand calibration pole to calculate hand measurements accurately.</td>
<td>Student has used the hand calibration pole to calculate hand measurements, but with some errors.</td>
<td>Student has used the hand calibration pole to calculate hand measurements, with accuracy and fluency.</td>
</tr>
<tr>
<td><strong>Understanding units in measurement, and use formulas for measuring</strong></td>
<td>Student has not demonstrated knowledge of units and formulas in calculating hand measurements.</td>
<td>Student has demonstrated some knowledge of units and formulas in calculating hand measurements, but their work contains some errors.</td>
<td>Student has demonstrated in-depth knowledge of units and formulas in calculating hand measurements, and has done so with accuracy and fluency.</td>
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<tr>
<td><strong>Using trigonometric functions to find values</strong></td>
<td>Student has not effectively applied knowledge of trigonometric functions to calculate measurements.</td>
<td>Student has applied knowledge of trigonometric functions to calculate measurements, but with some errors.</td>
<td>Student has applied knowledge of trigonometric ratios to calculate measurements, with accuracy and fluency.</td>
</tr>
</tbody>
</table>

**REFERENCES**

Polynesian Voyaging Society, Holding a Course:
http://pvs.kcc.hawaii.edu/ike/hookele/holding_a_course.html

Polynesian Voyaging Society, On Wayfinding:
http://pvs.kcc.hawaii.edu/ike/hookele/on_wayfinding.html

Exploratorium, Never Lost: Polynesian Navigation:
http://www.exploratorium.edu/neverlost/