Standard Benchmarks and Values

- Choose and demonstrate appropriate strategies to investigate and/or solve theoretical and applied problems.

- Evaluate and analyze mathematical concepts and properties.
How can we incorporate place-based learning into a mathematics class?

I teach math in Hawaii yet many of my students, even those of native Hawaiian ancestry, know little about ancient Hawaiian traditions. Often times native peoples struggle in western education systems because of the conflicting culture and ways of knowing. I wanted to make a lesson that reinforced mathematical concepts while teaching about Hawaiian culture so that my students, future teachers, could see how the power in place-based learning and ethnomathematics.

Enduring Understandings

Hands-on and place-based lessons can engage students and provide them with a deeper understanding of mathematical content.

Critical Skills and Concepts

- Use proportions to make a scaled drawing.
- Make use of symmetry to increase efficiency in task completion.
- Have an appreciation for how Hawaiian navigators use the star compass to steer a wa'a.
- Recognize the value in utilizing alternative methods to teach math content.
# Authentic Performance Task

The class will make a full-size drawing of Hōkūle'a from a scaled-down drawing. The drawing is a top-view of the hulls and deck.

## Authentic Audience
Polynesian Voyaging Society (PVS) crew member.

## Other Evidence
Class discussions and reflections.

## Learning Plan

<table>
<thead>
<tr>
<th>Est. Time</th>
<th>Activity</th>
<th>Key Words/Ideas</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 min.</td>
<td>Students will watch a short video on Hōkūle'a and Hawaiian voyaging traditions. <a href="http://vimeo.com/51118047">http://vimeo.com/51118047</a></td>
<td>Native Knowledge Hawaiin Renaissance</td>
</tr>
<tr>
<td>10 min.</td>
<td>Think, pair, share about the video and how it ties with education.</td>
<td>Place-based education</td>
</tr>
<tr>
<td>5 - 10 min.</td>
<td>Give students the handout with the simplified scaled drawing on top view of the Hōkūle'a. Inform students that as a class they need to scale that drawing life-size using sidewalk chalk and measuring sticks/tape outside. The class will discuss strategies to efficiently complete this task (lead them to delegate tasks and use symmetry). Have students form groups according to their delegation choices (such as one for the foreward section, one for the aft section, and one larger one for the middle.</td>
<td>Laulima Lōkahi Scale Ratio</td>
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<tr>
<td>10 min.</td>
<td>Ask students how they will determine the scale of the picture given to them. On the handout there is a line 1 ½ inches long, as a class figure out what distance that represents on the actual canoe. The full length of Hōkūle’a is 62’4” and on the drawing the length is 8 ½ inches. Some students may choose to convert the length to feet, making it 62 ⅜ feet. Either way, show them how to set up and solve a proportion. Therefore, the 1.5 - inch long line on the drawing represents 11 feet in real life.</td>
<td>Lōkahi Proportions Accuracy and Estimation</td>
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<tr>
<td>15+ min.</td>
<td>In their groups students will measure the scaled drawing and calculate the actual lengths to be drawn when they go outside. Check that each student is able to set up and solve the proportions necessary to complete this task. Then, students should complete their measurements and conversions for homework and be prepared to draw the following day.</td>
<td>Laulima Proportions Accuracy and Estimation</td>
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</table>
### Extensions
- For students knowledgable in trigonometry: Determine where along the palekana (safety railings), pale kai, and back rail the house markings should go.
- Field visit to a wa’a (E ala, Hōkūle‘a, Hawai‘i Loa,...).

### Adjustments
- To make the lesson simpler (and faster) make the scale easier than 1½ inches to 11 feet and/or remove some of the lines.
- For Grade 6 an adjusted version of this lesson would address the Common Core State Standards for Mathematics 6.RP.1, 6.RP.3, 6.EE.6, and 6.EE.7.
- For Grade 7 an adjusted version of this lesson would address the Common Core State Standard for Mathematics 7.RP.2, 7.NS.3, 7.EE.3, 7.EE.4, and 7.G.1.

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<td>30+ min.</td>
<td>Groups will be given sidewalk chalk and measuring sticks/tape. Outside in a large enough area determine where the pale kai (or pale wai) should go and instruct students to use that as a reference point for the rest of the drawing. In their groups, students will measure and draw the full size lengths from their calculations to recreate the drawing. If a group completes their task quicker than others then encourage them to help the rest of the class.</td>
<td>Laulima Lōkahi</td>
</tr>
<tr>
<td>10 min.</td>
<td>Answer students questions about wa‘a, voyaging, navigating, the World Wide Voyage, etc. Any that you cannot answer collect and send to PVS.</td>
<td></td>
</tr>
<tr>
<td>Optional</td>
<td>Go to each part drawn and ask the class to identify it from the labeled illustration of the Hōkūle‘a.</td>
<td></td>
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<tr>
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<td>Either instruct or remind students about the Hawaiian star compass. Stand on the kilo (navigator’s seat) and describe how to determine your heading using the sun and stars. While standing on the “wa‘a”, ask students questions such as “If Hōkūpa‘a is rising off your port beam, what direction is your heading?”</td>
<td></td>
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</table>
|          | For homework students will respond to:  
• “How did you feel during today’s class?”  
• “What math topics could be taught or strengthened by an activity like this?” and  
• “What did you personally learn today?” | |
Scaled Drawings and Hawaiian Navigation Techniques

Hōkūle‘a Drawing #1

Hōkūleʻa

Launched: March 8, 1975 Hakipu‘u - Kualoa, O‘ahu
Type: Wa‘a Kaulua (Double-Hulled Canoe)
Length Overall: 62’ 4”
Length at Waterline: 54’ 0”
Beam: 19’6”
Draft: 2’6”
Displacement (Fully Loaded): ~27,000 lbs.

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**Diagram:**
- **paepae / boom**
- **kaula paepae**
  - sheet line (for pulling open the sail and holding it in place)
- **kilo / navigator’s seat**
- **papa uila / solar panels**
- **manu hope / stern endpiece**
- **hoe uli / steering paddle or sweep**
- **hoe ‘ākea / starboard steering blade**
- **mō‘o / side board or gunwale**
- **kuamō‘o, kino, or ka‘ele / hull**
- **iwikuamo‘o / keel**
- **ʻiako / crossbeams joining the two hulls**
- **ʻeku / prow**
- **ʻākea / starboard hull**
- **ama / port hull**
- **pale wai or pale kai / splash guard**
- **pala / deck**
- **kapalina / canvas covers (for sleeping compartments on long voyages)**
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Scaled Drawings and Hawaiian Navigation Techniques
Hawaiian Star Compass
Scaled Drawings and Hawaiian Navigation Techniques
Hōkūleʻa Scaled Drawing