Teaching Science as Inquiry
Aquatic Professional Development Program:

Integrating the Ocean Into Middle and High School Science

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Aquatic Science as Context

- People are connected to the ocean
  - Practical
  - Personal

- Aquatic science is multi- and inter-disciplinary
  - Physics
  - Chemistry
  - Biology
  - Ecology

Teaching Science as Inquiry (TSI) Aquatic Professional Development (PD) Goals

1) Increase teachers’ content knowledge in aquatic science
2) Improve teachers’ science process and pedagogical knowledge
3) Improve student content and nature of science knowledge

TSI Aquatic PD Structure

Workshop 1: Introductory & Physical Aquatic Science Pedagogical foundation module
Online Follow-up
Interactive Online Learning Community
Face to Face Follow-up

Workshop 2: Chemical Aquatic Science
Workshop 3: Biological Aquatic Science
Workshop 4: Ecological Aquatic Science

TSI Professional Development Cohorts

Kaua’i ★ 2012-13
O’ahu ★ 2010-12 ★ 2012-13
Maui ★ 2011-12
Hawai’i ★ 2011-12

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Teacher Demographics (N=28)

Grade Level
• 2 Elementary School
• 15 Middle School
• 11 High School

Disciplines Taught
• 7 General science
• 10 Physical
• 5 Marine science
• 5 Biology
• 1 Chemistry

Teacher Majors
• 14 Science
• 9 Education
• 5 Others, including:
  • Business
  • Chinese literature
  • Religion

Ocean Literacy Principles (OLPs)
1. Earth has one big ocean with many features.
2. The ocean and life in the ocean shape the features of the earth.
3. The ocean is a major influence on weather and climate.
4. The ocean makes Earth habitable.
5. The ocean supports a great diversity of life and ecosystems.
6. The ocean and humans are inextricably interconnected.
7. The ocean is largely unexplored.

Research Questions
• How did teachers connect PD activities to the ocean?
• To what extent did connecting activities to the ocean engage students?
• To what extent did the PD increase teacher and student content knowledge?

Ocean Connections

Lesson Plans
• Most teachers made connection to the ocean
• Types of Connections
  • Content/theory–Density differences in the ocean cause water layers to form
  • Concrete examples–Students will research how river runoff affects how density change(s) when temperature and salinity changes
  • Personal examples–Many of my students have experienced cold, unmixed freshwater at the surface in Hanauma Bay. They can now explain why that’s happening.
  • Previous lessons–The last part of the activity was a discussion in which I guided students in connecting the activity to our previous activity on density (soda cans)
  • Use of questions–Has anyone ever experienced coming across patches/areas of water of different temperatures? Why do different places in the ocean have different temperature layers? What happens to areas where streams empty into the ocean? How does differences in density affect the ocean?

Student Engagement

Lesson Reflections (12 activities, 5-28 teachers/activity, 1-5 Likert Scale)
• Range in connections to ocean ($M = 2.07-4.22$)
• Range in engagement of students ($M = 2.45-4.5$)

Positive correlations between extent of connection to ocean and
• Engagement of students ($r = .81$, $p < 0.001$)
• Perception of increase in student content knowledge ($r = 0.42$, $p < 0.001$)

High level of engagement compared to non-TSI activities ($N = 28$, $M = 4.04-4.35$, 1-5 Likert Scale)
Teacher Content Knowledge

Ocean Literacy Principles (Pre-Post PD on 1–5 Likert Scale)
• Increase in knowledge (N = 28, t(27) = 7.88, p < 0.001)

Self-Assessment of Understanding of Activity’s Content

<table>
<thead>
<tr>
<th>Instrument</th>
<th>N Teachers</th>
<th>N Items</th>
<th>M</th>
<th>SD</th>
<th>Reliability</th>
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</thead>
<tbody>
<tr>
<td>Module 1 Pre</td>
<td>31</td>
<td>29</td>
<td>19.39 (67%)</td>
<td>5.33</td>
<td>.83</td>
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<tr>
<td>Module 1 Post</td>
<td>31</td>
<td>29</td>
<td>22.68 (78%)</td>
<td>4.58</td>
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<tr>
<td>Module 2 Pre</td>
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<td>38</td>
<td>25.14 (66%)</td>
<td>7.15</td>
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<tr>
<td>Module 2 Post</td>
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<td>38</td>
<td>30.10 (79%)</td>
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<tr>
<td>Module 3 Pre</td>
<td>28</td>
<td>36</td>
<td>19.71 (55%)</td>
<td>5.62</td>
<td>.80</td>
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<tr>
<td>Module 3 Post</td>
<td>28</td>
<td>36</td>
<td>24.00 (67%)</td>
<td>5.58</td>
<td>.81</td>
</tr>
<tr>
<td>Module 4 Pre</td>
<td>28</td>
<td>32</td>
<td>15.25 (45%)</td>
<td>4.39</td>
<td>.66</td>
</tr>
<tr>
<td>Module 4 Post</td>
<td>28</td>
<td>32</td>
<td>19.96 (59%)</td>
<td>4.90</td>
<td>.75</td>
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</table>

All pre-post differences were significant (p < .0001).

Student Content Knowledge

<table>
<thead>
<tr>
<th>Instrument*</th>
<th>N Students</th>
<th>M*</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module 1 Pre</td>
<td>497</td>
<td>4.36 (44%)</td>
<td>1.90</td>
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<tr>
<td>Module 1 Post</td>
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<td>5.11 (51%)</td>
<td>1.94</td>
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<tr>
<td>Module 2 Pre</td>
<td>373</td>
<td>3.12 (31%)</td>
<td>1.58</td>
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<tr>
<td>Module 2 Post</td>
<td>373</td>
<td>4.58 (46%)</td>
<td>1.89</td>
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<tr>
<td>Module 3 Pre</td>
<td>390</td>
<td>5.54 (53%)</td>
<td>2.29</td>
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<tr>
<td>Module 3 Post</td>
<td>390</td>
<td>6.24 (62%)</td>
<td>2.23</td>
</tr>
<tr>
<td>Module 4 Pre</td>
<td>372</td>
<td>3.49 (35%)</td>
<td>1.64</td>
</tr>
<tr>
<td>Module 4 Post</td>
<td>372</td>
<td>4.55 (46%)</td>
<td>1.85</td>
</tr>
</tbody>
</table>

*All tests are 10 items with 4 multiple-choice answer options.
**Percents are percent-correct scores.

All pre-post differences were significant (p < .0001)

Aquatic Science Implementation

Teachers of all disciplines can successfully integrate aquatic science principles into their classroom.

Connecting to the ocean engages students.

• Ocean theme pervaded workshop, OLPS aligned better to lesson progressions than individual activities.

• Content instruction was valued by participants.
  • MS teachers had lower content knowledge than HS teachers.
  • Teachers appreciated learning more about other subjects, but difficult to fit different disciplines into curriculum.
  • Discipline differences need to be further explored.

Exploring Our Fluid Earth

• Aquatic science inquiry curriculum

• Aligned to standards

• Live Aug. 2014

• Free! Sign up today!

Mahalo! Questions?