Using interactive OOI data visualizations to improve data literacy and scientific reasoning skills in undergraduate students

Gabriela Smalley¹, Sage Lichtenwalner², Andrea Drewes¹ and Kathy Browne¹

(1) Rider University, Lawrenceville, NJ, United States,
(2) Rutgers University, Marine and Coastal Sciences, New Brunswick, NJ, United States
Scientific Explanations: D-C-E-R Framework

Modified from McNeill & Krajcik, 2012

Data Descriptions (D): describe trends, patterns, ranges, outliers, similarities, differences, etc.

Claim (C): draw conclusions about the data and relevant phenomena

Evidence (E): relevant, appropriate, and sufficient data to address claim

Reasoning (R): scientific reasoning that ties evidence and relevant science concepts to claim

Modified from McNeill & Krajcik, 2012
Data Explorations: Provide Experiences with Data

Topics:
• Plate tectonics (various data sources)
• Temperature, Salinity, and Density profiles (ARGOS)
• Tides (OOI)
• Wind and Waves (OOI)
• Primary Production (OOI)

Student work:
• In class: Data descriptions (D) & Claim (C)
• Individually: Scientific explanation (C, E, R)
Course Information and Project Data Collected

Course Information
• Sections of Introductory Oceanography at Rider University, NJ
• Class size: ~30 students
• First-year to seniors
• Science and non-science majors
• Divided into two groups: intervention (with data exploration activities) and comparison (lecture only)

Data collected (Spring 21 - Fall 23):
• Data Exploration Activities (4 per semester)
  o Intervention group only
  o Group & Individual work
• Exam Essay Questions related to data interpretation (3, one per exam)
• Pre/Post semester surveys (modified versions of the following tools):
  o OCI: Ocean Concepts Inventory
  o VLAT: Visualization Literacy Assessment Test
  o LCTSR: Lawson’s Classroom Test of Scientific Reasoning
• Student Interviews
Results: Exam Essay Scores

Independent Samples t-Test: Intervention vs. comparison
* Significantly different at p<.001

- Intervention group: significantly higher scores than comparison group across most components (D, E, R; but not C)
- Both groups can make a correct claim, but intervention students are able to create evidence backed explanations with scientific reasoning while the comparison group struggles to do so
Results: Pre/Post Test Scores

**OCI** (Ocean Concepts Inventory)

<table>
<thead>
<tr>
<th></th>
<th>Pre test</th>
<th>Post test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>7</td>
<td>11</td>
</tr>
</tbody>
</table>

Intervention group had significantly larger improvement on OCI

**VLAT** (Visualization Literacy Assessment Test)

![VLAT Graph](image)

Intervention group score remained the same while comparison group score decreased...

**LCTSR** (Lawson’s Classroom Test of Scientific Reasoning)

![LCTSR Graph](image)

Scores did not change significantly for either group

Two-way Mixed ANOVA, Group*Pre/Post interaction
Summary, Conclusions

• Incorporation of data exploration activities resulted in significant improvements in data descriptions and the ability to create evidence-backed explanations with scientific reasoning

• Activities also resulted in significant improvements of ocean content knowledge (OCI) by the end of the semester

• Data visualization (VLAT) & Scientific reasoning (LCTSR) tests:
  • End of semester fatigue...?
  • Are tests really measuring the skills targeted in our study?
  • One semester may not be enough time to show improvements?

• How important is data description (D) to students’ ability to create scientific explanations?
Thank you!

Gabi Smalley gsmalley@rider.edu
Sage Lichtenwalner sage@marine.rutgers.edu
Andrea Drewes adrewes@rider.edu
Kathy Browne browne@rider.edu

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Ocean Data Labs widgets for Rider University

These widgets were developed to support courses at Rider University as part of the project Improving Undergraduate Scientific Explanations: Exploring the Role of Data Literacy Skills in Scientific Reasoning.

1. Tectonic Plate Boundaries
2. T/S/D Profiles
3. Waves & Weather
4. Coastal Tides
5. Primary Production

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https://datalab.marine.rutgers.edu/explorations/rider/