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

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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

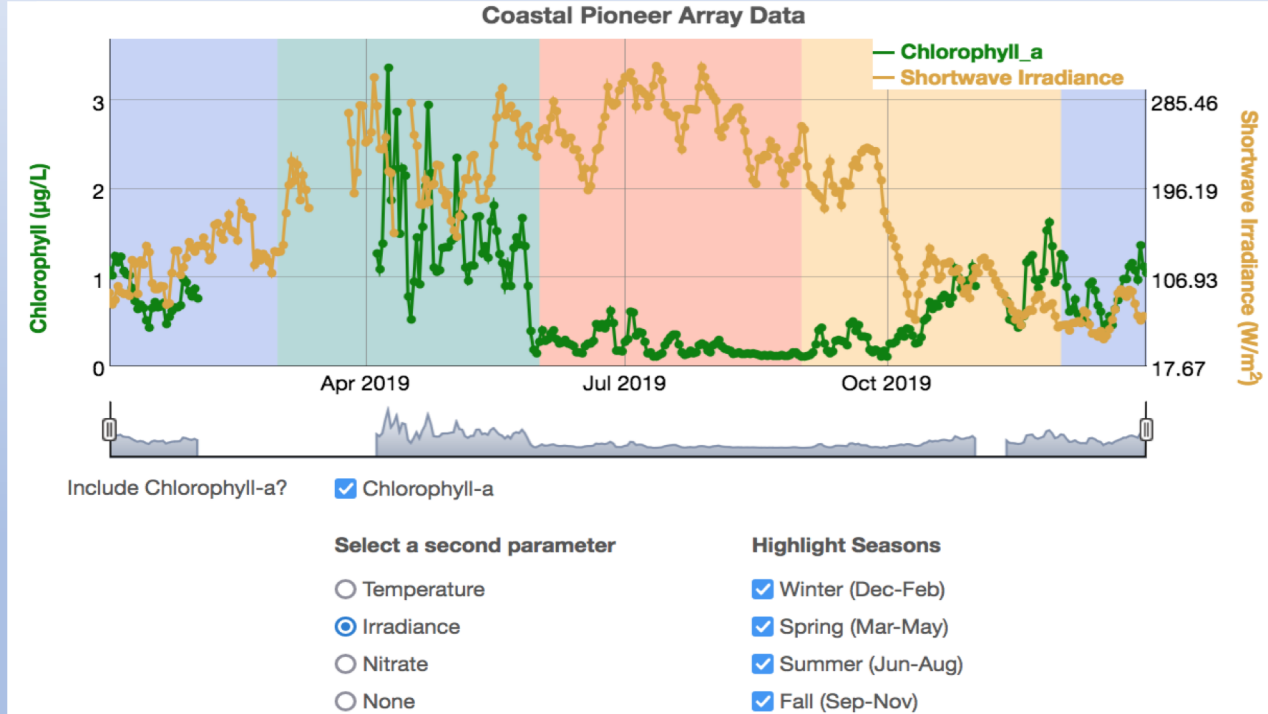
Data Explorations: Provide Experiences with Data

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)

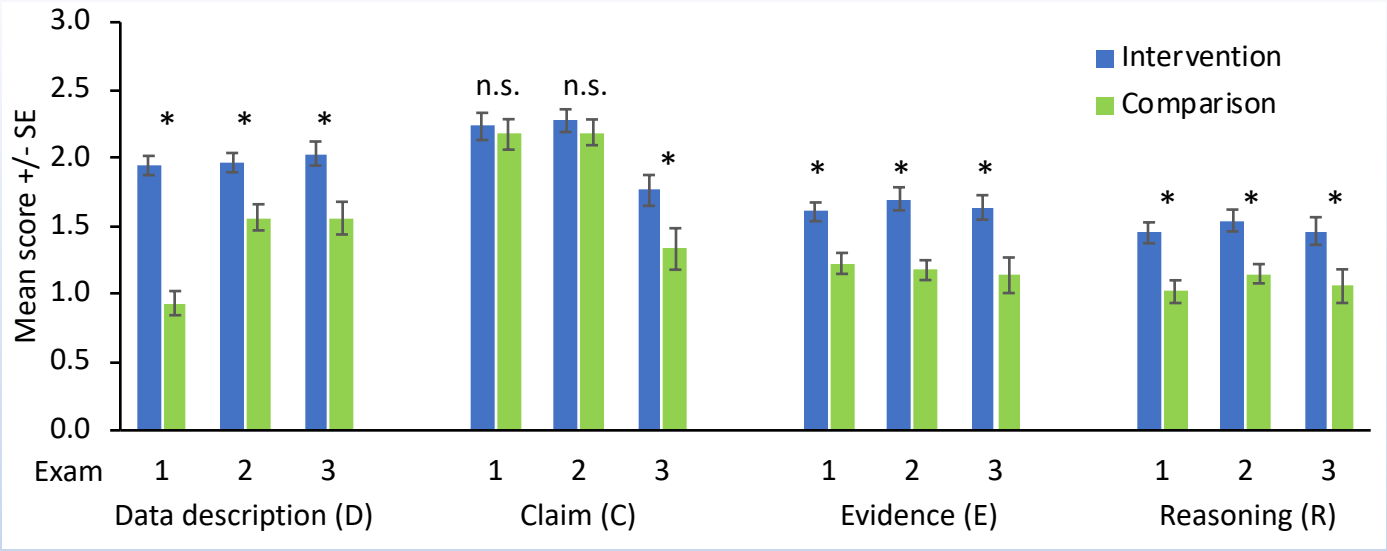
Data collected (Spring 21 - Fall 23)**:**

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

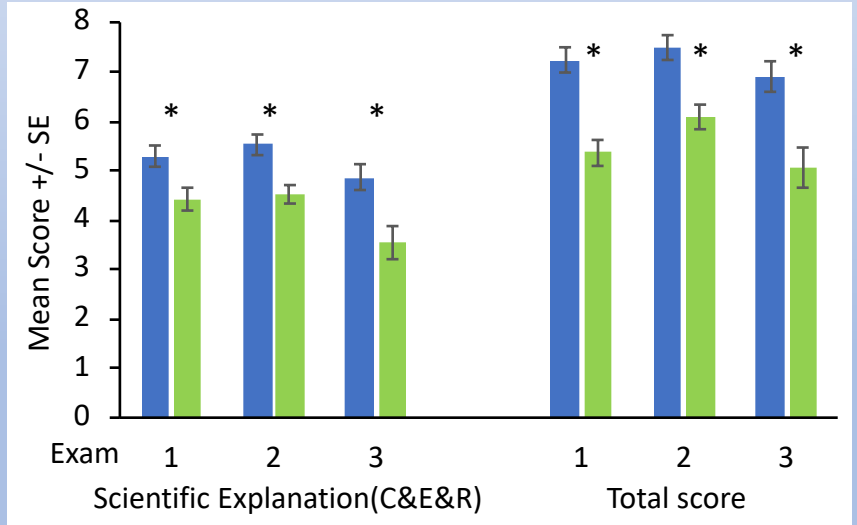
Results: Exam Essay Scores

Independent Samples t-Test: Intervention vs. comparison

* Significantly different at p<.001



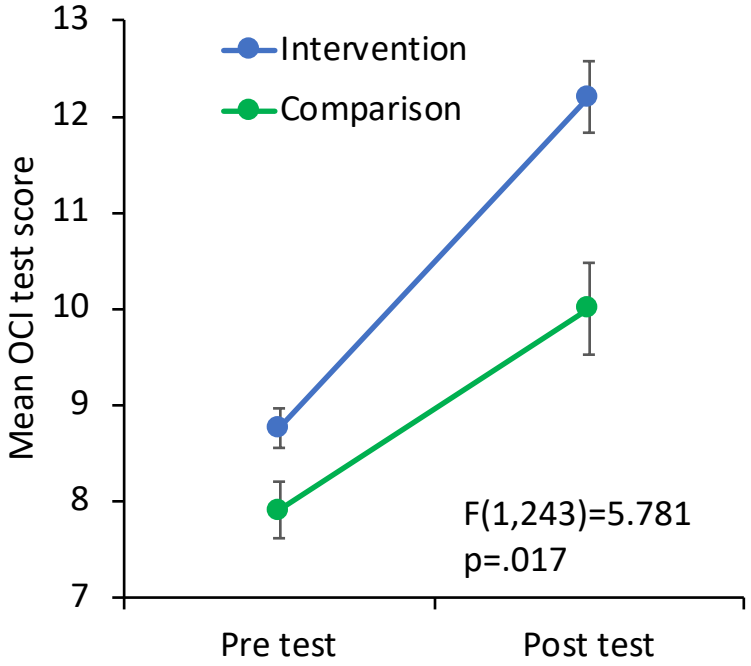
- Intervention group: significantly higher scores than comparison group across most components (D, E, R; but not C)
- Both groups can make a correct claim, but intervention students are able to create evidence backed explanations with scientific reasoning while the comparison group struggles to do so



Results: Pre/Post Test Scores

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

OCI (Ocean Concepts Inventory)

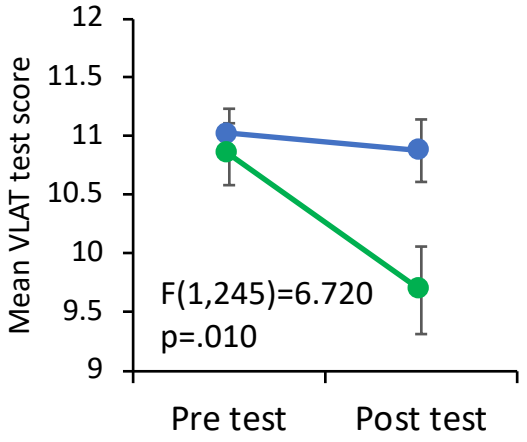


Intervention group had significantly larger improvement on OCI

VLAT

(Visualization Literacy Assessment Test)

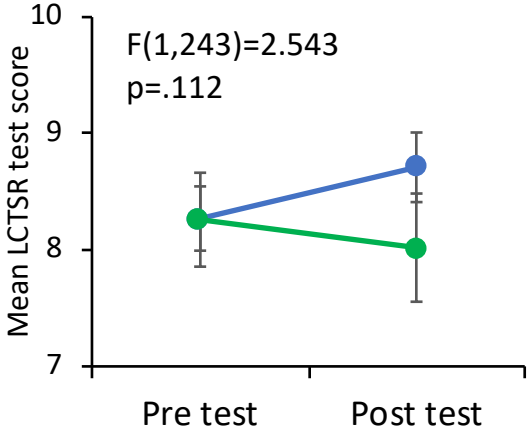
Intervention group score remained the same while comparison group score decreased…



LCTSR

(Lawson's Classroom Test of Scientific Reasoning)

Scores did not change significantly for either group



Summary, Conclusions

- Incorporation of data exploration activities resulted to 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!

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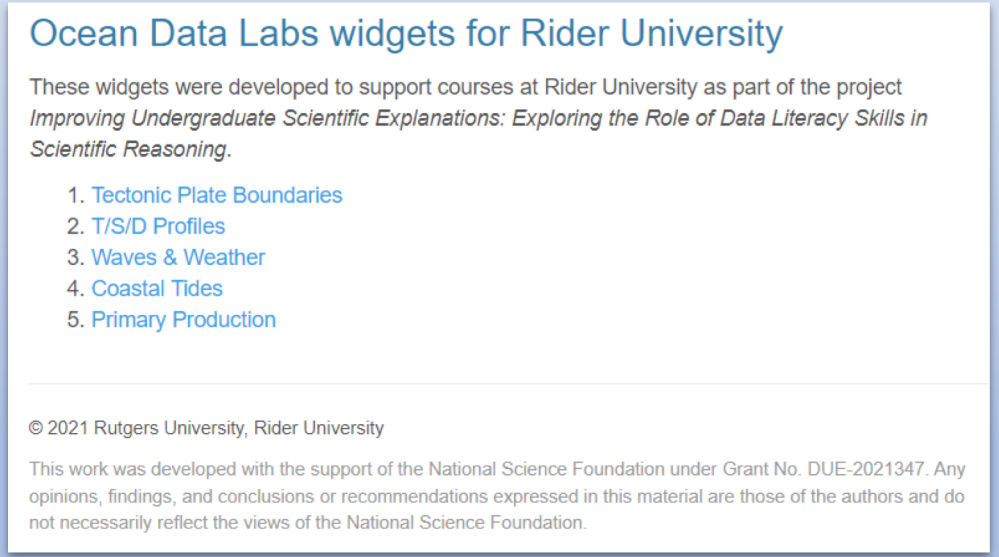
Level 1, Engaged Student Learning Track



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/