

An Introductory Oceanography lab sequence implementing a combination of OOI Data Labs and basic lab science experiments

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Abstract

- Introductory Oceanography courses are popular with students across all majors. Specifically non-science majors are often more interested in taking oceanography to fulfill a lab science requirement than, e.g., chemistry or physics.
- In this presentation, I describe the development of a non-traditional lab sequence to accompany an Introductory Oceanography course designed to fulfill a basic lab science requirement for non-science majors at a primarily undergraduate, landlocked institution without an oceanography program.
- The lab sequence includes basic lab science experiments (e.g., pressure at depth, buoyancy, density stratification, mixing, waves, etc.) and implementations of some of the ocean data labs developed as part of the Ocean Observatories Initiative (OOI).
- The course was first taught during the Fall 2023 semester, and I discuss lessons learned and student feedback on this first iteration of the course.

Background for Course Design

- Basic lab science course aimed at fulfilling the “Natural Science Perspective” of the WNE General University Requirements
 - Requires specifically recording, reporting, and interpreting data.
 - Learning Outcomes assessed through exams and lab reports
- Student population: non-majors
- **Lab**: designed as a mixture of more traditional lab experiments (involving measurements, graphing, calculations, data interpretation, lab reports/worksheets) and OOI Data labs
 - Goal for first time: use OOI data labs mostly “as is”; figure out what works, what doesn’t, and how long it takes the students to complete the tasks
 - Very limited funds to develop lab experiments
 - Design lab experiments mostly with already available equipment
- **Lecture**: selection of standard introduction to oceanography topics (shown below) similar to intro to oceanography course without a lab which I have been teaching to non-majors (in-person or online-asynchronous) for 10 years

Course Topics

- History of ocean exploration
- Earth's formation and internal structure, formation of Earth's oceans
- Plate tectonics, ocean floor topography, bathymetry
- Marine sediments
- Properties of water and seawater
- Air – sea interactions, atmospheric circulation, hurricanes
- Ocean circulation
- Waves and Tides
- Coasts
- Pollution
- Primary Productivity
- Food webs

Lab Sequence

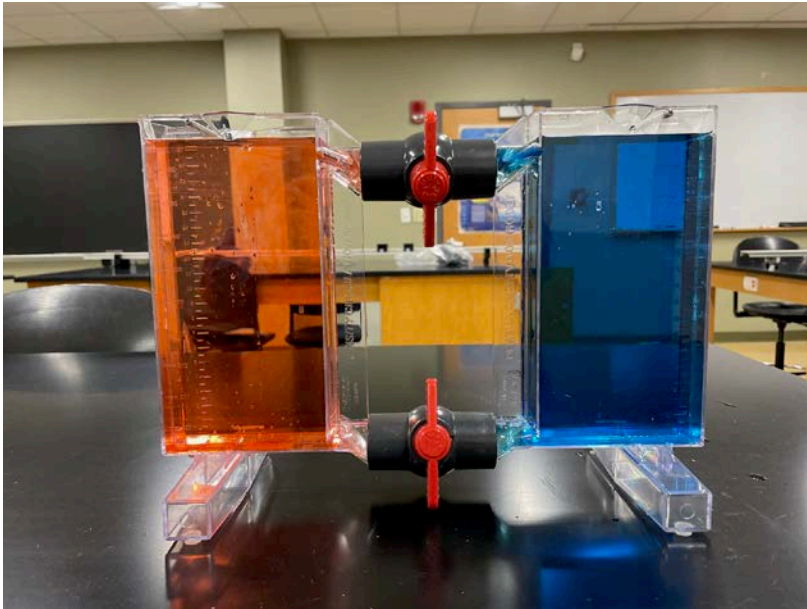
- Measurement, units, uncertainties, and density
- Latitude, longitude, and nautical charts
- Buoyancy and pressure in a fluid
- **OOI Data Lab: Lab 1 (1.1,1.2,1.4) and Lab 3**
 - (Lab 1: Introduction to OOI; Lab 3: Plate Tectonics and the seafloor)
- **OOI Data Lab: Lab 2 (2.1,2.4,2.5)**
 - (Lab 2: Building Data Skills – The display of oceanographic data)
- Temperature and heat capacity of water
- **OOI Data Lab: Lab 5**
 - (Lab 5: Ocean Chemistry – Investigating Density and Stratification in the Ocean)
- Salinity/Temperature Mixing and Stratification
- Waves
- **OOI Data Lab: Lab 6 (6.1,6.2,6.4)**
 - (Lab 6: Ocean Physics – Waves Generated by Large Storms)

Example of Lab Experiment: Pressure Variation with Depth

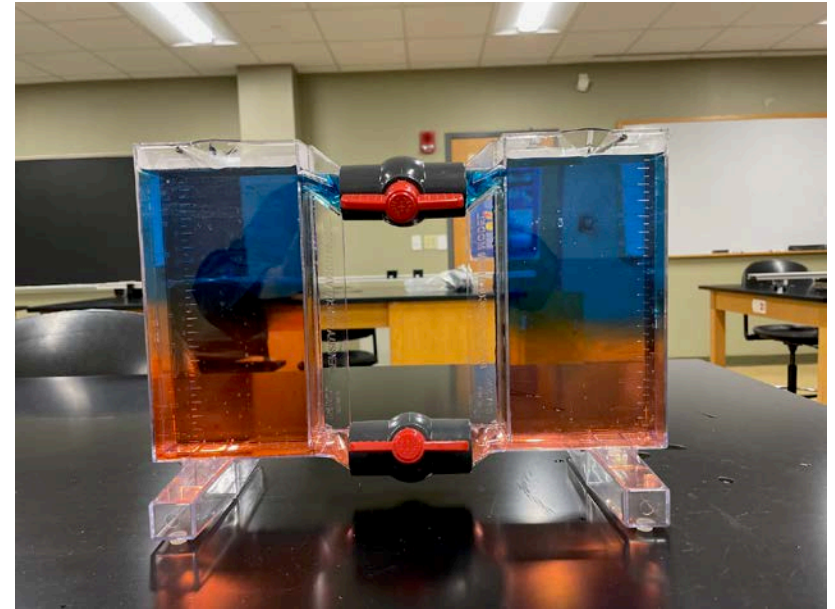


- Measure weight of cylinder with water using balance. Convert to pressure on bottom of cylinder.
- Measure height of water column using ruler.
- Plot pressure vs. water depth to find linear relationship and extract density of water from slope.

Example of Lab Experiment: Salinity/Temperature Mixing and Stratification



Valves closed (Blue: hot water)



Shortly after valves have been opened

- Water of different temperature or different salinity. Food coloring.
- Open valves to start mixing process.
- Future expansion: Use temperature or salinity sensor to study stratification more quantitatively.

Example of Lab Experiment: Buoyancy and Archimedes Principle



Mass of cylinder in air



Mass of cylinder in water

- Compare weight of cylinder in air to weight when submerged to find buoyant force.
- Find weight of water that fits in sleeve to verify Archimedes Principle.

Cylinder and sleeve



Implementation Challenges

- Limited funds for lab experiments
- Prior to start: Unknown level of student preparedness
 - Background of students in Fall 2023:
 - Two groups:
 - **Group 1:** Senior business majors that still needed a lab science to graduate.
 - **Group 2:** First-semester “pre-science” majors. These students did not get accepted into the regular science major that they applied to due to gaps in math and chemistry background. At freshman orientation, they were registered for a bridge chemistry course and the oceanography lab course.
 - Composition required “on the fly” adjustment to level of quantitative skills/reasoning that could be expected as a base line.

Student Feedback on Data Labs

Students were very positive about the labs. I did not receive negative comment about them.

Some sample comments:

- “I liked that these labs were straight forward”.
- “I loved playing with the pictures. The videos were nice, too.”
- “I liked how simple they were, even if it made me think hard! Sometimes they were too easy in a way.”

Plans for the Future

- Expand some of the experiments with PASCO sensors, e.g., temperature and salinity sensors etc.
 - Will help bridge gap between simple lab measurements and time series/vertical profiles used in OOI Data Labs
 - Will require additional funds, so will be implemented in stages over next couple of years
- Find additional (maybe more complex but still feasible) ocean-related experiments to include
- Add/subtract/modify some of the questions used in the OOI Data labs with now a better understanding of the time it takes students to complete these labs, where they get “stuck”, etc.
- Built in a couple more OOI Data Labs, specifically ones about biological oceanography
- Develop/implement assessment tools specifically related to OOI Data labs