The OOI Ocean Education Portal

Ocean Sciences 2014
Workshop for 2YC Faculty
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Agenda

• What is Data?
  – OOI Visualization Tools

• How can we use data in teaching?
  – The OOI Data Investigation Builder
  – An Example Data Investigation Activity

• Reflection
This is what we teach – 5 Ocean Gyres
But this is what the World Ocean looks like.

Complex Circulation defines the Ocean Gyres
What is Data?
Survey Data Activity

Let’s start off by collecting some data right now!
Where did you grow up?

1. Northeast
2. Southeast
3. Midwest
4. South Central
5. Northwest
6. Southwest
7. Outside of the “Lower 48”
How many years have you been teaching?

1. Less than 5
2. 5 to 10
3. 10 to 20
4. 20+
What is your favorite animal at the aquarium?

1. Class Actinopterygii
2. Class Asteroidea
3. Class Chondrichthyes
4. Family Delphinidae
5. Family Otariidae
6. Class Scyphozoa
What is your favorite animal at the aquarium? - 2

1. Class Actinopterygii - Ray-finned Fish
2. Class Asteroidea - Sea Stars
3. Class Chondrichthyes - Sharks
4. Family Delphinidae - Dolphins
5. Family Otariidae - Sea Lions
6. Class Scyphozoa - Jellyfish
How do you define “data”? 

1. A Star Trek character played by Brent Spiner.
2. A collection of facts from which conclusions may be drawn.
3. The raw material of information stored within a computer or file.
4. The information collected during a scientific study.
5. The numbers that come out of an instrument or machine.
What is Data?

And where can we find it?

Anywhere!

You can find plenty of data online, or you can collect it yourself.
Stock Market

Dow Jones Industrial Average - Add to Portfolio - Discuss DJI

9,319.83
-5.18 (-0.06%)

Open: 9,326.04  Mkt Cap: -
High: 9,410.55  52Wk High: 13,990.65  P/E: -
Low: 9,255.48  52Wk Low: 7,882.51  F P/E: -
Vol: 179.25M  Avg Vol: 335.66M  Beta: -

Historical Prices - Link to chart

Tip: You can drag the chart.

Real-time data provided by INDEXDJX - Disclaimer
NYC STUDENTS MAKE SUSTAINED, STEADY PROGRESS IN MATH AND ELA

Since 2002, the percentage of students meeting or exceeding State standards is up 27.7 points in 4th grade math and up 29.8 points in 8th grade math. In ELA, the percentage is up 14.8 points in 4th grade and 13.5 points in 8th grade.
Election (2 views)
The Ocean Observatories Initiative

Global  Regional  Coastal

(A) Inshore Surface-Piercing Profiler Mooring
(B) Inshore Surface Mooring
(C) Central Inshore Profiler Mooring
(D) Central Surface-Piercing Profiler Mooring
(E) Central Surface Mooring
(F) Central Offshore Profiler Mooring
(G) Offshore Profiler Mooring
(H) Offshore Surface Mooring
(I) Upstream Inshore Profiler Mooring
(J) Upstream Offshore Profiler Mooring
What is “Visualization”?  

Visual analysis is not primarily about the pictures, but about finding ways to use our powerful visual systems to analyze data. It's analysis done in a visual way. It's visual exploration, visual data analysis, and visual presentation of results.”

Robert Kosara, eagereyes.org
EPE Design Philosophy

EPE Visualization Tools are designed to be:

- **Simple**
  - Intuitive & easy to use
- **Interactive**
  - To support deeper understanding
- **Customizable**
  - Adapt them to fit your learning goals
- **Embeddable**
  - Place them in context within your lessons
- **Focused**
  - Learning outcome driven, not data driven – these are not your typical comprehensive data visualization tools
- **Educational**
  - Primary goal is to aid students’ analysis and understanding of scientific processes, not dealing with data formats and graphing
An Educator’s Visualization Tool

Driving Questions:
This tool will allow students to analyze single glider profiles (also called casts) to investigate the following questions:

• How do measurements vary over the depth of the water column?
• How does the shape of a particular measurement’s profile vary over time and/or location?
Glider Profile Explorer

Glider Deployment: Blue - Gliderpalooza 2013
Start Time: 2013-09-06 13:47:00
End Time: 2013-09-18 12:51:00

Profile 1214
Location
Latitude: 40.214398
Longitude: -71.345588
Direction
2013-09-18 12:51:00

Seawater Temperature (°C)
How can we use data in teaching?
Why are we doing this?

“The growth of big data has given rise to a whole new class of questions that need to be asked and answered. We need new tools to help students learn techniques for seeing patterns in data, and for analyzing and interpreting data in ways similar to those practiced by scientists and mathematicians.”

—Wayne Harvey, Vice President, EDC
Data-enhanced learning experiences, including activities in which students collect and interpret their own data and/or those in which they explore research databases to answer questions.

Data enhanced learning experiences can:

- **Prepare students to address real-world complex problems**;
- **Develop students’ ability to use scientific methods, including consideration of the values and ethics of working with data**;
- **Teach students how to critically evaluate the integrity and robustness of data or evidence and of their consequent interpretations or conclusions**; and
- **Provide training in scientific, technical, quantitative, and communication skills**.

Manduca and Mogk 2002. Using Data in Undergraduate Science Classrooms (Grant NSF-0127298)
**Why is it important to teach with data?**

Because science *is* “….the use of evidence to construct testable explanations and predictions...” (National Academy of Sciences)

- Words (narratives, textbook descriptions, analogy/metaphor)
- Physical models (static models (e.g. syncline)
- working model (e.g. stream table)
- Computer models
- Drawings
- Photographs, Video
- Maps
- Data-based visualizations (including graphs)

Kastens 2010.
Are we stuck on the left?

Business Intelligence

Technology-centric, engineering-oriented
- report
- store
- integrate
- transform
- clean
- collect

Human-centric, design-oriented
- predict
- monitor
- communicate
- analyze
- explore

Terminology for the Data Investigation Builder

Syllabus: Scope and Sequence
What is important to student learning (themes and concepts)

Curriculum

Unit 2

Unit 1

Lesson A

Lesson B

Lesson C

Lesson D

Data Investigation 1
Data Investigation 2
Data Investigation 3

Data Investigation 1
Data Investigation 2
Data Investigation 3

Data Investigation 1
Data Investigation 2
Data Investigation 3

Data Investigation 1
Data Investigation 2
Data Investigation 3
Claims, Evidence, and Reasoning

What students expect:

Data → Reasoning → Claim

Many claims in Earth Science are based on the preponderance of the evidence from multiple lines of data-based reasoning.
Student Argumentation Skills..

focused on analyzing evidence and backing up their claims. The ability to make and understand scientific claims, analyze evidence, and develop arguments from the analysis of data is critical to student learning success and to compete in the modern workforce.
Learning Sciences

Building theory in education through the design and empirical testing of learning environments that are:

1. Knowledge centered
2. Learner centered
3. Assessment centered
4. Situated within a learning community

NRC: How People Learn (Bransford, Brown & Cocking, 1999)
Knowledge Centered

- Inquiry-based and organized around questions/problems
- Data driven activities.
- Investigations conclude with the development of a scientific explanation

Mirrors scientific practice
(Duschl, 1990; Donovan & Bransford, 2005)
Student Centered

- Initial questions serve to surface students ‘prior knowledge
- Investigation help students build understandings of the core concepts
- There are opportunities to reflect on learning and compare initial ideas to final ideas

Surface, build, and revise ideas
(Driver et al., 1996; Ford & Forman, 2006)
Assessment Centered

- Formative assessment is critical for learning
- Supports professors in tailoring instruction to meet students’ needs

**The Spatial Response from Hurricane Sandy**

*Created by: sage*

In this activity, students will study the ocean’s response to Hurricane Sandy as it passed through the Mid-Atlantic and made landfall. Students will analyze air pressure, winds, waves, and sea level to describe the temporal and spatial responses.

**Develop an Explanation**

Recall that the research question you are trying to address is:

> Analyze data from several buoys to describe how waves and sea level respond to a passing hurricane.

As you consider the data you just investigated, consider the following questions:

1. What were the atmospheric responses to Hurricane Sandy?
2. How did the ocean respond?
3. How did the response differ based on which side of the storm a station was on?
4. How should emergency response managers take this information into account when planning evacuations for future storms?

**Assessment**

- The goal of this exercise is to write up a description and analysis of the provided datasets.
- **Instructions**
  
  Using the datasets provided, describe how waves and sea level along the coast of New Jersey responded as Hurricane Sandy approached. Include an analysis of how the response varied along the coast, and how that variation compared with the location of the storm.

**Make thinking visible**

(Black & Wiliam, 1998; Bransford, Brown & Cocking, 2000)
LET’S TRY IT OUT
Reflection

• How could you use this tool in your class or with your students?
• How can we make the tool easier to use?
• How can we make the tool more useful, that is, how should we modify or adapt this tool to support your learning goals?
A Framework for Using Data in Education
What Do Educators Want?

Top requested features:
- **Data visualization tools** (ability to graph, map, chart data)
- Inquiry-based lessons/activities
- Lesson plans for teaching science concepts with RTD
- Locally relevant data sets
- **Map interfaces**
- Stories or case studies that show how scientists use real-time data.

Middle-school teachers were more likely to have students use:
- Computers at school as part of their lessons
- The Internet/websites at school as part of their lessons
- Real-time data (mostly student-collected data) as part of their lessons
Levels of Engagement

What can we as educators do to support learners at different levels, so they can successfully work with data, and build the next level of skill?
The three levels of engagement

• **Orientation**
  – Using data is very new to learners; they need a lot of guidance from the educator(s).

• **Interpretation**
  – Learners have basic data skills, and are practicing applying data to what they are studying about a topic.

• **Synthesis**
  – Learners are skilled at “reading” data, and can proceed to using it as evidence to construct conclusions about the science.
Four Categories of Data

• **Real Time Data (RTD)**
  Data that are being collected currently, and can be accessed as they are collected to study current conditions or events

• **Archived data**
  Data that document past conditions or events; used to put present conditions into context

• **Simulated data**
  Data that look realistic, but were created using real data to emphasize a particular science concept or concepts

• **Learner Generated data**
  Data that are measured and/or calculated by learners as part of the activity.
# A Framework for Data Visualization

## Cognitive Levels of Different Audiences

<table>
<thead>
<tr>
<th>Raw Data</th>
<th>User Tutorials</th>
<th>Directed Inquiry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Graduate Students</td>
<td>Older Students</td>
<td>Guided Inquiry</td>
</tr>
<tr>
<td>Researchers</td>
<td>Typical Users (fishermen, decision/policy makers, transportation, etc.)</td>
<td>Full Inquiry</td>
</tr>
</tbody>
</table>

## Data Complexity

- **Raw Data**
- **Visualization Tools**
- **Canned Images**

## Scientific Aptitude

- **Directed Inquiry**
- **Guided Inquiry**
- **Full Inquiry**

**OCEAN SCIENCES 2YC WORKSHOP**
Ocean Leadership
February 23, 2014
FIN