# A Scaffolded Approach to Data Literacy Skills in 2YC Students using Authentic Data from OOI and other Sources

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## What are students' perceptions of, & skills with large, real-world oceanographic data visualizations in 2YC students?

## Introduction:

Up to 80% of 2YC students have math anxiety & a survey of undergraduate biology students found that 60-80% had not previously worked with authentic data.[1, 3] In addition, students may struggle to work with data and visualizations due to limited previous experiences and exposure.[2, 5] Data literacy skills are needed by undergraduates to become fluent in working with authentic data and align with expected on-the-job skills.

The Ocean Data Labs lab manual: ***Exploring the Ocean with OOI Data,*** was created to provide high quality open access (OER) ocean data literacy activities that allow undergraduates to use real-world oceanographic data from the OOI in accessible ways, while being easy for professors to integrate into their teaching. It supports undergraduate students by enhancing graph interpretation skills, recognition of patterns, critical thinking skills and provide opportunity to work with large, professionally collected data sets. Within the collection **Lab 2: Building Data Skills - The Display of Oceanographic Data**[6] orients students to different types of data using a scaffolded learning cycle approach. The activities are carefully crafted to teach students how to orient themselves to various oceanographic data visualizations, recognize trend patterns and correlations, interpret 'messy' data and apply their knowledge.

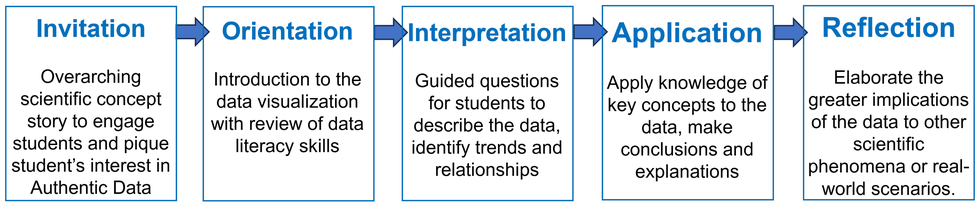


Figure 1. Ocean Data Lab Manual scaffolded learning cycle. This framework combines learning concepts from the Lawrence Hall of Science[7] and Levels of Engagement with Data[4].

## Methods:

A pilot study was conducted to determine if the lab activity changed student perception and skills working with data visualizations. Pre and post surveys were administered to Introductory 2YC oceanography students in asynchronous online courses during the Fall 2023 and Spring 2024 before and after completing the Ocean Data Lab 2: Building Data Skills - The Display of Oceanographic Data. Students were asked about each data visualization type: simple scatter plot, time series, bubble chart, messy scatter plot, vertical profile(F2) . Questions were about:

- Opinions and feelings (Table 1)
- Familiarity (Table 2)
- identifying data points
- map/chart data interpretation
- identifying patterns in data

to determine if students' perceptions and familiarity changed after the activity and if there was increased understanding of the data visualizations.

**Data Visualizations (graphics) in Survey**

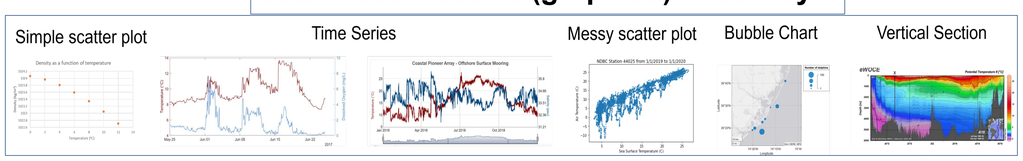


Figure. 2

**Table 1. Student Perceptions About Data Visualizations (multiselect questions)**

| | |
|---|---|
| disinterested | confident |
| confused | interested |
| scared | relaxed |
| dread | excitement |
| anxiety | joy |
| frustration | intrigued |
| challenged | fascinated |
| neutral | |

**Table 2: Familiarity with Data Visualizations**

1. **Not familiar at all (I have never seen a graphic like this before)**
2. **Slightly familiar (I've only seen a similar or simpler graphic and I don't know where to start)**
3. **Somewhat familiar (I've seen similar these before but not completely comfortable trying to interpret)**
4. **Moderately familiar (I'm comfortable trying to interpret but might have some questions)**
5. **Very familiar (can interpret without assistance)**

## Results and Discussion:

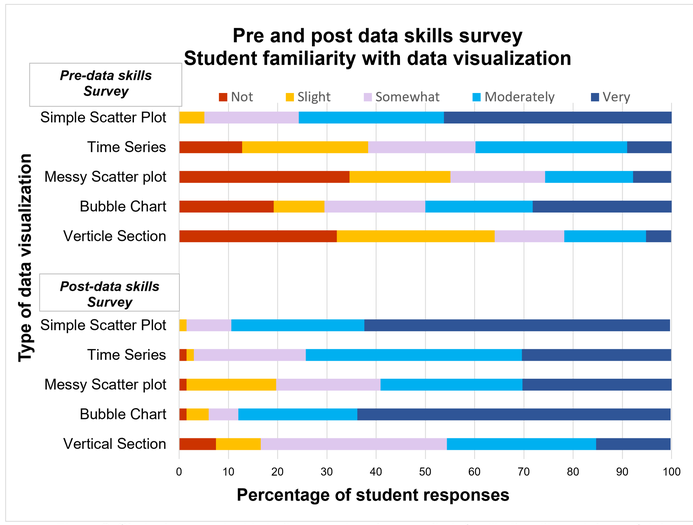


Figure 3. Student were asked in both pre and post survey their familiarity with each type of data visualization.

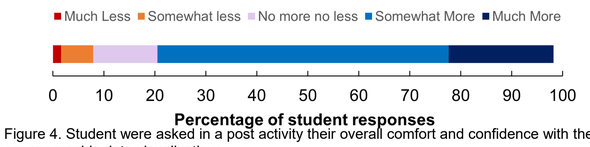


Figure 4. Student were asked in a post activity their overall comfort and confidence with the oceanographic data visualizations.

**What helped students better understand data visualizations?**

- *Scaffolding – slow stepped intro to skills*
- *Videos within activity*
- *Quick check questions for practice*

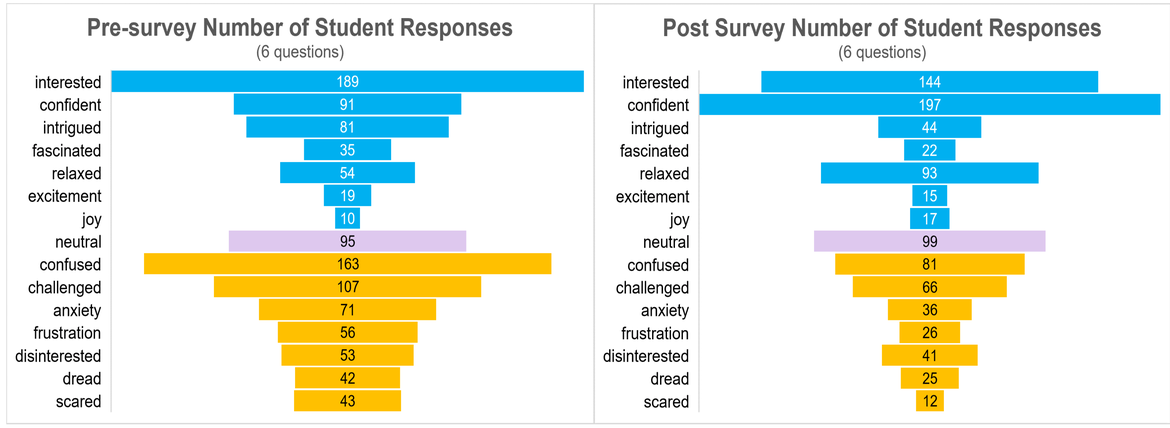


Figure 5. Student were asked in both pre and post survey to identify their opinions and feelings for each type of data visualization. The questions were unlimited multi-select. The above graphs represents the compiled responses on for the 6 visualizations for the pre-survey (right) n= 1109 responses and post survey (left) n=918 responses.

Sixty-four (n=64) students completed the pre & post surveys across 5 different classes after 16 students were removed from the survey because they did not complete one of the surveys. A paired proportion test was used to determine change in pre & post feelings and correct answers to data interpretation questions.

**Student Perceptions:** The pre-survey indicated that students were most familiar with a simple scatter plot and least familiar with vertical sections (F3). Percentage of students 'not familiar at all' with the other data visualizations ranged from 12 to 36%. Post survey indicated that students had increased familiarity with all graphics and 78% of the students reported they were 'somewhat' or 'much more' comfortable and confident reading & interpreting data visualizations while 8% became less (F4).

There was statistical significance for each question for total reduction of negative and increase in positive perceptions between pre and post, except for the positive impressions for the vertical profile & all neutral. Students' familiarity with graphics increased across all types as did their comfort and confidence with reading and interpreting the data after completing the activity (F5). Student's overall negative perceptions decreased for every graphic, most notably they were less confused, challenged, anxious and scared.

**Data Interpretation:** As expected, introductory students were most familiar (87% pre; 91% post) with a simple linear scatter plot and were correct reading (90%) and identifying the trend (93% post) for it. Students also did very well on the three bubble chart questions both pre & post ranging from 81-93.8%. Statistically significant change in correct answers were: the question on the dual Y-axis time series for maximum temperature increased from 55% to 76.6%; recognition of trend type on the messy scatter plot increased from 79.7% to 98.4% and the dual Y-axis time series trend increased from 55% to 73.4%. While the other interpretation questions increase slightly, it was not statistically significant ($P<0.05$).

Overall students familiarity with the data visualizations increased across all types as did their comfort and confidence with reading and interpreting the data after completing the activity. Student's negative perceptions decreased for every graphic, most notably they were less confused, challenge, anxious and scared of the graphics while positive perceptions increased the most for confidence and relaxed.

The Data Lab Manual activities assist students needs by placing information into relevant context, self-checking knowledge throughout the activities and promoting self-directed discovery to support undergraduate students that would benefit from more practice with data skills. The learning objectives for Lab 2 were met and overall this pilot study indicates that students perceptions became much less negative and slightly more positive by completing the activity. We hope to expand this study to additional colleges and universities.

**References**

1. Beilock, S.L. & Willingham, D.T. 2014. Math Anxiety: Can Teachers Help Students Reduce It? Am. Ed.. Summer: 28-43.
2. Chinn, C.A., & Brewer, W.F. (1998). An empirical test of a taxonomy of responses to anomalous data in science. J. of Research in Science Teaching: 35(6), 623-654.
3. Ellwein, A.L., L.M. Hartley, S. Donovan, and I. Billick. 2014. Using Rich Context and Data Exploration to Improve Engagement with Climate Data and Data Literacy: Bringing a Field Station into the College Classroom. J. Geoscience Ed., 62: 578-586.
4. Hotaling, L., J. McDonnell, C Ferraro, K. Florio and S. Lichtenwalner. 2017. Educating with Data. In Exemplary Practices in Marine Science Education: A Resource for Practitioners and Researchers, Springer Int. Pub.
5. Resnick, I., Kastens, K.A., & Shipley, T.F. (2018). How students' reason about visualizations from large professionally collected data sets: A study of students approaching the threshold of data proficiency. J. Geoscience Ed., 66(1), 55-76.
6. Sahl, L., Pfeiffer-Herbert, A.S., Bristol, D.L. & Lichtenwalner, S. 2021. Lab 2 Building Data Skills-the Display of Oceanographic Data. In Bristol, D.L. and Pfeiffer-Herbert, A. (Eds.), Ocean Data Labs: Exploring the Ocean with OOI Data – Online Laboratory Manual. 2nd edition. Rutgers, The State University of New Jersey.
7. The Regents of the University of California. 2015. The learning cycle. Session 4: Designing Learning Experiences. The Lawrence Hall of Science, UC Berkeley

Scan to link to Data lab 2

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