DR K–12 Exploratory Project:

**Oceans of Data**— *In what ways can research on learning inform the design of interfaces and technology tools to be used by students accessing large scientific databases?*

**October 2010–October 2012**

Education Development Center, Inc. and Scripps Institution of Oceanography

"I'll pause for a moment so you can let this information sink in."

Realizing the potential of scientific cyberinfrastructures to change the way science is taught

Science is not just a body of knowledge that reflects current understanding of the world; it is also a set of practices used to establish, extend, and refine that knowledge. Both elements—knowledge and practice—are essential.

*Next Generation Framework for K-12 Science Education, NRC 2011, p. 2-3*
The Challenge: Bridging interfaces built for scientists to novice users

- Remotely-collected data
- Large, complex data sets
- Expert data access and data representations may be baffling to students
What does it take to engage students in scientific data that are accessible online?

- Teacher facilitation
- Easy access to data
- Curriculum and organizational supports
- Student-friendly data analysis/visualization tools
- Scientific expertise
Interface Design: Building a Foundation

Scientific CI → Electronic interfaces and technology tools for educational use → Curricula involving data accessed using CI → Teaching and classroom practices
What we did: reviewed/coded literature

- Annals of the Association of American Geographers
- Applied Cognitive Psychology
- Behavior and Information Technology
- The Cartographic Journal
- Computers in Human Behavior
- Contemporary Educational Psychology
- Educational Studies in Mathematics
- Ergonomics
- European Journal of Psychology and Education
- Geoforum
- Geographical Research
- Instructional Science
- Journal of the American Statistical Association
- Journal of Computing in Higher Education
- Journal of Educational Psychology

- Journal of Experimental Psychology: General
- Journal of Experimental Psychology: Learning, Memory, and Cognition
- Journal of Geography
- Journal of the Learning Sciences
- Journal of Research in Mathematics Education
- Journal of Science, Education and Technology
- Learning and Instruction
- Professional Geographer
- Review of Educational Research
- Science
- Science Education
- Technical Communications Quarterly
- Technology Innovations in Statistics Education
- Technology, Pedagogy and Education
What we did: consulted experts

Oceans of Data Advisory Board

Yi Chao, Principal Scientist, Jet Propulsion Laboratory
Daniel Edelson, Vice President of Education, National Geographic
William Finzer, Senior Scientist, KCP Technologies
Allison Fundis, Research Scientist and Education and Public Outreach Liaison, Oceans Observatories Initiative RSN, University of Washington
Boris Goldowsky, Director of Technology, Center for Applied Special Technology
James Hammerman, Senior Research & Evaluator, TERC
Kim Kastens, Doherty Senior Research Scientist, Lamont-Doherty Earth Observatory, Columbia University
Julianne Mueller-Northcott, Biology and Earth Science Teacher, Souhegan High School, Amherst, NH
John Orcutt, Professor of Geophysics, Scripps Institution of Oceanography, UCSD
William Sandoval, Associate Professor of Psychological Studies in Education, Graduate School of Education and Information Studies, UCLA
What we’ve learned

What an expert sees on a data access page or in a visualization will not be what a novice sees

Source: http://www.ngdc.noaa.gov/mgg/image/crustageposter.gif
Visual perception = information processing

Perceived differences in light level and wavelength, spatial position (impacted by what is "eye-catching" & what we are looking for)

Rough sketch of spatial properties, form & movement

Match with/ map onto existing knowledge, identify features, interpret & extract meanings

New/ revised schema (mental image)

AMOUNT OF INFORMATION

Automatic/ Pre-Attentive

Short-Term Memory

Long-Term Memory

VISUAL CORTEX
Cross Cutting Guideline: Adjust Cognitive Load

Short-term (working) memory – limited capacity

- Intrinsic Cognitive Load
- Germane Cognitive Load
- Extraneous Cognitive Load
Cross Cutting Guideline: **Adjust Cognitive Load**

Short-term (working) memory – limited capacity

- Intrinsic Cognitive Load
- Germane Cognitive Load
- Extraneous Cognitive Load
Accessing data should be fast and easy

- There should be low to no barriers to downloading and visualizing a data set
- Minimize expert terminology

http://www7.ncdc.noaa.gov/CDO/CDOMarineSelect.jsp
There should be low to no barriers to downloading and visualizing a data set

Automate processes not important to the learning goals
-> Include information to minimize confusion
-> Provide color palette options to match the nature of the data and task

Default color palette

Alternative color palette

Source: http://mynasadata.larc.nasa.gov/
Variations in luminance (rather than hue) are best for showing fine structure and shape.

There are issues with the common default spectral color palette.

Chlorophyll
Design for errors

Source: Data-enhanced Investigations for Climate Change Education (development site) PI Dan Zalles,
Use interactive features, 2D and 3D displays, shading, and other visual effects to help students visualize spatial data.

Data visualization created by Patrick Robinson

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Provide data visualizations and tools that support the teaching of scientific practices.
Complete set of guidelines and explanations are in

**The Oceans of Data Project Team:**

Ruth Krumhansl, PI, Education Development Center, Inc. (EDC) rkrumphansl@edc.org

Cheryl Peach, PI, Scripps Institution of Oceanography cpeach@ucsd.edu

June Foster, co-PI, EDC

Amy Busey, EDC

Irene Baker, EDC

Jackie DeLisi, EDC