Collaborative Research: Centers for Ocean Science Education Excellence - Oceans in the Earth-Sun System

Annette deCharon

Principal Investigator; University of Maine, Orono, annette.decharon@maine.edu

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Project Participants

Senior Personnel

Name: deCharon, Annette

Worked for more than 160 Hours: Yes

Contribution to Project:
COSEE-OS Principal Investigator, University of Maine, involved with all aspects; Currently serving as Lead of the COSEE Web Working Group (WWG) and Chair of the COSEE Council; Overseeing the re-design effort for COSEE.net and its Content Management System.

Name: Cline, Amy

Worked for more than 160 Hours: Yes

Contribution to Project:
Education and Outreach Coordinator, University of New Hampshire, concept mapping, meeting facilitator, project evaluation, coordination of 'Seasons in the Sea' (2006), 'Climate and Oceans - Using Ocean Based Data' (2007), and 'Understanding Seasonal Change in the Ocean Using Ocean Observing Data' (2008) workshops; Recently relocated to Philadelphia, PA, Ms Cline has increased time spent on COSEE-OS activities (e.g., connecting COSEE-OS content to the 'Seasons in the Sea' exhibit at the Seacoast Science Center in Rye, NH).

Name: Farrin, Lynn

Worked for more than 160 Hours: No

Contribution to Project:
Educational research consultant for 'Science Curriculum Topic Study' and 'Phenomena and Representations for Instruction of Science in Middle Schools (PRISMS)'

Name: Fields, David

Worked for more than 160 Hours: No

Contribution to Project:
Concept mapping and scientific review

Name: Goes, Joaquim

Worked for more than 160 Hours: No

Contribution to Project:
Concept mapping, scientific review, 'Oceans in the News' contributor; Guest presenter for the 'Climate and Oceans - Using Ocean Based Data' workshop (2007)

Name: Harris, Walter

Worked for more than 160 Hours: No

Contribution to Project:
Center overall evaluation

Name: Huntington, Thomas

Worked for more than 160 Hours: Yes

Contribution to Project:
Concept mapping, scientific review, 'Oceans in the News' contributor
Name: Jumars, Peter  
**Worked for more than 160 Hours:** No  
**Contribution to Project:** Concept mapping and scientific review

Name: Karp-Boss, Lee  
**Worked for more than 160 Hours:** Yes  
**Contribution to Project:** Research Assistant Professor, University of Maine, instructor for 'Teaching Physical Sciences by Ocean Inquiry' semester course and 'Teaching Sciences by Ocean Inquiry' workshop, scientific review of educator resources

Name: Lindsay, Sara  
**Worked for more than 160 Hours:** No  
**Contribution to Project:** Concept mapping and scientific review

Name: Morrison, Ru  
**Worked for more than 160 Hours:** No  
**Contribution to Project:** Concept mapping and scientific review

Name: Pendse, Sheila  
**Worked for more than 160 Hours:** No  
**Contribution to Project:** Center overall evaluation. Affiliation with COSEE-OS ended in spring 2007.

Name: Pennock, Jonathan  
**Worked for more than 160 Hours:** No  
**Contribution to Project:** Concept mapping and scientific review

Name: Perry, Mary Jane  
**Worked for more than 160 Hours:** No  
**Contribution to Project:** Concept mapping within undergraduate and graduate courses and for NSF-sponsored research project ?Autonomous Measurements of Carbon Fluxes in the North Atlantic Bloom? (NSF 0628107), scientific review

Name: Stepanauskas, Ramunas  
**Worked for more than 160 Hours:** No  
**Contribution to Project:** Concept mapping and scientific review

Name: Wiley, Mark  
**Worked for more than 160 Hours:** No  
**Contribution to Project:** Center overall evaluation

Name: Boss, Emmanuel  
**Worked for more than 160 Hours:** Yes  
**Contribution to Project:** Instructor for 'Teaching Physical Sciences by Ocean Inquiry' semester course and 'Teaching Sciences by Ocean Inquiry' workshop, scientific review of educator resources

Name: Campbell, Janet
Worked for more than 160 Hours: Yes
Contribution to Project:
Science presenter of 'Seasons in the Sea' and 'Climate and Oceans - Using Ocean Based Data' workshops

Name: Keeley, Page

Worked for more than 160 Hours: No
Contribution to Project:
Application of findings from / to 'Science Curriculum Topic Study'; ; President-elect National Science Teachers Association (2007-08)

Name: Owen, Beth

Worked for more than 160 Hours: No
Contribution to Project:
Informal education reviewer of educator resources

Name: Shyka, Tom

Worked for more than 160 Hours: No
Contribution to Project:
Programmatic support for 'Seasons in the Sea' and 'Climate and Oceans - Using Ocean Based Data' workshops

Name: Weller, Herman

Worked for more than 160 Hours: Yes
Contribution to Project:
Instructor for 'Teaching Physical Sciences by Ocean Inquiry' semester course and 'Teaching Sciences by Ocean Inquiry' workshop

Name: Eberle, Francis

Worked for more than 160 Hours: No
Contribution to Project:
Executive Director, Maine Mathematics and Science Alliance, advisor to COSEE-OS; Recently appointed Executive Director of the National Science Teachers Association (beginning August 2008)

Name: Chick, Perrin

Worked for more than 160 Hours: No
Contribution to Project:
Education Director, Seacoast Science Center, collaborating with Amy Cline to use COSEE-OS content and resources to augment their ?Seasons in the Sea? exhibit for various audiences

Name: Girguis, Peter

Worked for more than 160 Hours: No
Contribution to Project:
Assistant Professor of Biology, Harvard University, scientific contributor of hydrothermal vent-related content into COSEE-OS ?Concept-Linked Integrated Media Builder (CLIMB)?; Presenter at National Science Teachers Association Short Course, ?COSEE: Salting Away for Our Future: Resources for Understanding the Ocean?s Role in Climate Change? (March 2008)

Name: Gomes, Helga

Worked for more than 160 Hours: Yes
Contribution to Project:
Research Associate, Bigelow Laboratory for Ocean Sciences, concept mapping, scientific review, 'Oceans in the News' lead contributor

Name: Herren, Christen

Worked for more than 160 Hours: Yes
Contribution to Project:
Research Associate, COSEE-OS; Responsible for uploading content for the COSEE-OS ?Ocean-Climate Interactive? (OCI) and testing the COSEE-OS ?Concept Map Builder? and ?Concept-Linked Integrated Media Builder (CLIMB).?
Name: Repa, Theodore  
**Worked for more than 160 Hours:** No  
**Contribution to Project:**  
President, Repa & Associates; COSEE-OS Evaluator (as of spring 2008)

Name: Roesler, Collin  
**Worked for more than 160 Hours:** Yes  
**Contribution to Project:**  

Name: Salisbury, Joseph  
**Worked for more than 160 Hours:** No  
**Contribution to Project:**  
Participating Scientist in two COSEE-OS workshops (July 2008 at UNH and June 2009 at Seacoast Science Center)

Name: Chai, Fei  
**Worked for more than 160 Hours:** No  
**Contribution to Project:**  
Participating Scientist in COSEE-OS workshop (November 2008 at UMaine Darling Marine Center)

Name: Pershing, Andrew  
**Worked for more than 160 Hours:** No  
**Contribution to Project:**  
Participating Scientist in COSEE-OS workshop (July 2008 at UNH)

Name: Burakowski, Elizabeth  
**Worked for more than 160 Hours:** No  
**Contribution to Project:**  
Participating Scientist in COSEE-OS workshop (March 2009 at UNH)

Name: Jordan, Carolyn  
**Worked for more than 160 Hours:** No  
**Contribution to Project:**  
Participating Scientist in COSEE-OS workshop (March 2009 at UNH)

Name: Kalnejais, Linda  
**Worked for more than 160 Hours:** No  
**Contribution to Project:**  
Participating Scientist in COSEE-OS workshop (March 2009 at UNH)

Name: Moore, Timothy  
**Worked for more than 160 Hours:** No  
**Contribution to Project:**  
Participating Scientist in COSEE-OS workshop (March 2009 at UNH)

Name: Feng, Hui  
**Worked for more than 160 Hours:** No  
**Contribution to Project:**  
Participating Scientist in COSEE-OS workshop (June 2009 at Seacoast Science Center)

Name: Schloss, Annette  
**Worked for more than 160 Hours:** No  
**Contribution to Project:**  
Participating Scientist in COSEE-OS workshop (June 2009 at Seacoast Science Center)
Name: Graham, Monty  
**Worked for more than 160 Hours:** No  
**Contribution to Project:** Participating scientist in COSEE-OS workshop at the National Science Teachers Association (NSTA) conference (New Orleans, March 2009)

Name: Gundersen, Kjell  
**Worked for more than 160 Hours:** No  
**Contribution to Project:** Participating scientist in COSEE-OS workshop at the National Science Teachers Association (NSTA) conference (New Orleans, March 2009)

Name: Orcutt, Karen  
**Worked for more than 160 Hours:** No  
**Contribution to Project:** Participating scientist in COSEE-OS workshop at the National Science Teachers Association (NSTA) conference (New Orleans, March 2009)

Name: Milroy, Scott  
**Worked for more than 160 Hours:** No  
**Contribution to Project:** Participating scientist in COSEE-OS workshop at the National Science Teachers Association (NSTA) conference (New Orleans, March 2009)

Name: Beaudry, Jeffrey  
**Worked for more than 160 Hours:** No  
**Contribution to Project:** Education Researcher who participated as an observer in two COSEE-OS workshops (March 2009 at UNH & June 2009 at Seacoast Science Center)

Name: Companion, Carla  
**Worked for more than 160 Hours:** Yes  
**Contribution to Project:** COSEE-OS Research Associate

Name: Steinman, Medea  
**Worked for more than 160 Hours:** Yes  
**Contribution to Project:** COSEE-OS Marine Education Associate

Name: Lackovic, Randy  
**Worked for more than 160 Hours:** Yes  
**Contribution to Project:** COSEE-OS Librarian

Name: Adams, Nikki  
**Worked for more than 160 Hours:** No  
**Contribution to Project:** Featured scientist at Cal Poly San Luis Obispo workshop (collaboration with COSEE-Pacific Partnerships)

Name: Choboter, Paul  
**Worked for more than 160 Hours:** No  
**Contribution to Project:** Featured scientist at Cal Poly San Luis Obispo workshop (collaboration with COSEE-Pacific Partnerships)

Name: Moline, Mark  
**Worked for more than 160 Hours:** No
Contribution to Project:
Featured scientist at Cal Poly San Luis Obispo workshop (collaboration with COSEE-Pacific Partnerships)
Name: Tomanek, Lars
Worked for more than 160 Hours: No

Contribution to Project:
Featured scientist at Cal Poly San Luis Obispo workshop (collaboration with COSEE-Pacific Partnerships)
Name: Avery, David
Worked for more than 160 Hours: No

Contribution to Project:
Featured scientist at UConn workshop
Name: O'Donnell, James
Worked for more than 160 Hours: No

Contribution to Project:
Featured scientist at UConn workshop
Name: Vlahos, Penny
Worked for more than 160 Hours: No

Contribution to Project:
Featured scientist at UConn workshop
Name: Whitney, Michael
Worked for more than 160 Hours: No

Contribution to Project:
Featured scientist at Darling Marine Center 'Faculty-Graduate Student' workshop
Name: Twinning, Benjamin
Worked for more than 160 Hours: No

Contribution to Project:
Featured scientist at Darling Marine Center 'Faculty-Graduate Student' workshop
Name: Mayer, Larry
Worked for more than 160 Hours: No

Contribution to Project:
Research-based Online Learning Event (ROLE) Model Webinar presenter
Name: Wahle, Richard
Worked for more than 160 Hours: No

Contribution to Project:
Many Learning Pathways in the Ocean Sciences Webinar Presenter
Name: De La Rocha, Christina
Worked for more than 160 Hours: No

Contribution to Project:
Many Learning Pathways in the Ocean Sciences Webinar Presenter
Name: Landerer, Felix
Worked for more than 160 Hours: No

Contribution to Project:
'Concept Map Training Session at the Jet Propulsion Laboratory (JPL)' and scientist presenter at the NASA/JPL
'Scientist-Educator Collaborative Workshop' (June 3-4, 2011)
Name: Lee, Tony
Worked for more than 160 Hours: No
Contribution to Project:
Scientist presenter at the NASA/JPL 'Scientist-Educator Collaborative Workshop' (June 3-4, 2011)

Name: Menemenlis, Dimitris
Worked for more than 160 Hours: No
Contribution to Project:
Scientist presenter at the NASA/JPL 'Scientist-Educator Collaborative Workshop' (June 3-4, 2011)

Name: Willis, Josh
Worked for more than 160 Hours: No
Contribution to Project:
Scientist presenter at the NASA/JPL 'Scientist-Educator Collaborative Workshop' (June 3-4, 2011)

Name: Zlotnicki, Victor
Worked for more than 160 Hours: No
Contribution to Project:
Scientist presenter at the NASA/JPL 'Scientist-Educator Collaborative Workshop' (June 3-4, 2011)

Name: Vazquez, Jorge
Worked for more than 160 Hours: No
Contribution to Project:
Scientist presenter at the NASA/JPL 'Scientist-Educator Collaborative Workshop' (June 3-4, 2011)

Name: Lagerloef, Gary
Worked for more than 160 Hours: No
Contribution to Project:
Scientist presenter for the 'The Aquarius Mission: Key Scientific Connections Between Salinity, the Water Cycle, Ocean Circulation, and Climate' webinar

Name: Hobbs, Will
Worked for more than 160 Hours: No
Contribution to Project:
Concept Map Training Session at the Jet Propulsion Laboratory (JPL) on April 6, 2011

Name: Mahadevan, Amala
Worked for more than 160 Hours: No
Contribution to Project:
Scientist presenter for the 'North Atlantic Bloom' webinar series

Name: D'Asaro, Eric
Worked for more than 160 Hours: No
Contribution to Project:
Scientist presenter for the 'North Atlantic Bloom' webinar series

Name: Poulton, Nicole
Worked for more than 160 Hours: No
Contribution to Project:
Scientist presenter for the 'North Atlantic Bloom' webinar series

Name: Cetinic, Ivona
Worked for more than 160 Hours: No
Contribution to Project:
Scientist presenter for the 'North Atlantic Bloom' webinar series
Name: Lee, Craig  
**Worked for more than 160 Hours:** No  
**Contribution to Project:** Scientist presenter for the 'North Atlantic Bloom' webinar series

Name: Richardson, Annie  
**Worked for more than 160 Hours:** No  
**Contribution to Project:** Jet Propulsion Laboratory facilitator for COSEE-NASA collaborations (e.g., workshops, webinars)

**Post-doc**

**Graduate Student**

Name: Smith, Lori  
**Worked for more than 160 Hours:** Yes  
**Contribution to Project:** Center overall evaluation

Name: Albright, Jennifer  
**Worked for more than 160 Hours:** Yes  
**Contribution to Project:** Master's candidate in Secondary Science Education, University of Maine and Graduate Research Assistant for COSEE-OS; Responsible for uploading content for the COSEE-OS ?Ocean-Climate Interactive? (OCI) and testing the COSEE-OS ?Concept Map Builder? and ?Concept-Linked Integrated Media Builder? (CLIMB).

Name: Merrill, Margaret  
**Worked for more than 160 Hours:** No  
**Contribution to Project:** Doctoral candidate in Elementary Education, University of Maine, is researching ways that elementary classroom teachers can use COSEE-OS resources and tools to improve understanding of ocean-climate systems

Name: Goodwin, Deb  
**Worked for more than 160 Hours:** No  
**Contribution to Project:** Participating Scientist in COSEE-OS workshop (June 2009 at Seacoast Science Center)

Name: Armbrecht, Carrie  
**Worked for more than 160 Hours:** Yes  
**Contribution to Project:** University of Maine School of Marine Sciences Master's student whose thesis project uses COSEE-OS tools

Name: Needles, Lisa  
**Worked for more than 160 Hours:** No  
**Contribution to Project:** Featured scientist at Cal Poly San Luis Obispo workshop (collaboration with COSEE-Pacific Partnerships)

Name: Heinonen, Kari  
**Worked for more than 160 Hours:** No  
**Contribution to Project:** Featured scientist at UConn workshop

**Undergraduate Student**

Name: Casey, Adam  
**Worked for more than 160 Hours:** Yes
Contribution to Project:
Undergraduate in University of Maine School of Marine Sciences (graduated in spring 2008), 2007 summer intern for COSEE-OS

Technician, Programmer

Name: Graham, Sean

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Cousins, Steve

Worked for more than 160 Hours: Yes

Contribution to Project:
COSEE-OS web server procurement and set-up; Technical lead for COSEE.net transition from VIMS to UMaine server, including ?ALLCOSEE.net? listserve, ?COSEE News? update feature, etc

Name: Taylor, Lisa

Worked for more than 160 Hours: Yes

Contribution to Project:
Applied COSEE Network template design to COSEE-OS website

Name: Gonzalez, Rose-Marie

Worked for more than 160 Hours: Yes

Contribution to Project:
Technical Staff, Raytheon Web Solutions, Project Manager for COSEE.net and Content Management System re-design

Name: Martin, David

Worked for more than 160 Hours: Yes

Contribution to Project:
Technical Staff, Raytheon Web Solutions, Database lead for COSEE-OS ?Ocean-Climate Interactive? (OCI), ?Concept Map Builder? (CMB) and ?Concept-Linked Integrated Media Builder (CLIMB)?

Name: Smith, Harman

Worked for more than 160 Hours: No

Contribution to Project:
Technical Staff, Raytheon Web Solutions, Design Lead for COSEE.net and Content Management System re-design

Name: Wieclawek, Joseph

Worked for more than 160 Hours: Yes

Contribution to Project:
Technical Staff, Raytheon Web Solutions, Database lead for COSEE.net and Content Management System re-design

Name: Manahan, Abigail

Worked for more than 160 Hours: No

Contribution to Project:
Technical assistant to COSEE-OS Program

Other Participant

Name: Day-Miller, Elizabeth

Worked for more than 160 Hours: No

Contribution to Project:
Manager, BridgeWater Education Consulting (marine education evaluation, instruction and program coordination services) and former NSF Assistant Program Director for Ocean Sciences Education; COSEE-OS External Advisory Committee member.
Name: Keller, Thomas
Worked for more than 160 Hours: No
Contribution to Project:
Program Officer at the National Research Council, National Academies' Board on Science Education; COSEE-OS External Advisory Committee member.

Name: Payne, Diana
Worked for more than 160 Hours: No
Contribution to Project:
Education Coordinator for Connecticut Sea Grant and Assistant Professor in Residence at UConn's Neag School of Education; COSEE-OS External Advisory Committee member.

Name: Shair, Fred
Worked for more than 160 Hours: No
Contribution to Project:
Retired Professor of Chemical Engineering at Caltech and former Manager of the NASA Jet Propulsion Laboratory's Educational Affairs Office; COSEE-OS External Advisory Committee member.

Name: Sohus, Anita
Worked for more than 160 Hours: No
Contribution to Project:
Informal Education Lead at NASA's Jet Propulsion Laboratory and co-creator of the NASA Museum Alliance; COSEE-OS External Advisory Committee member

Name: Feller, Robert
Worked for more than 160 Hours: No
Contribution to Project:

Research Experience for Undergraduates

Organizational Partners

University of Maine
Center of COSEE-OS Program activities (as of Oct-06); host summer educator workshops at the Darling Marine Center ('Teaching Sciences by Ocean Inquiry'; offered the first-ever collaborative semester course between the College of Education & Human Development and School of Marine Sciences for senior undergraduates and Master's level students ('Teaching Physical Sciences by Ocean Inquiry').

University of New Hampshire
Extended their summer in-service teacher workshops to incorporate COSEE-OS content and evaluation of activities including evaluating working concept maps and draft web interfaces; conduct annual workshop at UNH; Has begun working with the Seacoast Science Center (Rye, NH) to use COSEE-OS resources to augment its 'Seasons in the Sea' exhibit.

Maine Mathematics and Science Alliance
Advises COSEE-OS on current educational research and development that will guide the concept mapping process and inform on pedagogical practices as they pertain to the project goals; COSEE-OS is working with MMSA staff on their recent NOAA Environmental Literacy grant 'Earth as a System is Essential - Seasons and the Seas (EaSiE)?'

Bigelow Laboratory for Ocean Sciences
Focuses their efforts on editorial review of 'Oceans in the News' articles and scientific review of concept-based educational resources.
Seacoast Science Center, Inc.
Through its tools and services, COSEE-OS is helping improve the Seacoast Science Center's interactions with UNH research scientists

Other Collaborators or Contacts
Margaret Powell ? Associate Professor Reading, Liberal Arts Department, St. Louis Community College - Florissant Valley, facilitated the December 2005 concept mapping process with scientists.
Ann Taylor ? Elementary Program Director, Department of Curriculum and Instruction, Southern Illinois University - Edwardsville, facilitated the December 2005 concept mapping process with scientists.
George Matsumoto ? Senior Education and Research Specialist, Monterey Bay Aquarium Research Institute (MBARI), provided ten experienced 'Education And Research: Testing Hypotheses (EARTH)' educators for 'Climate and Oceans - Using Ocean Based Data' workshop (2007).
Yi Chao ? Section Manager, NASA Jet Propulsion Laboratory: Earth Remote Sensing, provides leveraging opportunities for education-related ocean sciences computer modeling and information technology efforts; Participant in NASA/Aquarius webinars and workshops.
Susie Valatis ? Vice President, Institute for Broadening Participation, have held preliminary discussions on linkages between COSEE-OS and the NSF-funded ?Pathways to STEM? program.

Activities and Findings

Research and Education Activities: (See PDF version submitted by PI at the end of the report)

Findings: (See PDF version submitted by PI at the end of the report)

Training and Development:
See 'Project Activities' and 'Project Findings' documents

Outreach Activities:
See Appendix A of 'Project Activities' report

Journal Publications


Lagerloef, G; Colomb, FR; Le Vine, D; Wentz, F; Yueh, S; Ruf, C; Lilly, J; Gunn, J; Chao, Y; deCharon, A; Feldman, G; Swift, C. "THE AQUARIUS/SAC-D MISSION: DESIGNED TO MEET THE SALINITY REMOTE-SENSING CHALLENGE". OCEANOGRAPHY, p. 68, vol. 21, (2008). Published,


Books or Other One-time Publications


Bibliography: "Oceanography" magazine, v. 22(3), 52 pages

Web/Internet Site

URL(s):
http://cosee.umaine.edu/

Description:
Website gives overview of COSEE-OS and also serves as a launching point for modules described under various categories.

Other Specific Products

Product Type:
Teaching aids

Product Description:
COSEE-OS developed a suite of multimedia tools designed to enhance the teaching of ocean and climate science. In two linked applications -- the Ocean Climate Interactive (OCI) and Concept Map Builder (CMB) - concept mapping is used as a foundation for learners to make connections between fundamental concepts in ocean and climate science. These cost-free online tools have been incrementally developed, tested, and refined over the course of a series of teacher/scientist professional development workshops to maximize their efficacy. These tools are meant to supplement their education and outreach efforts to help them more effectively reach their target audiences through ongoing evaluation efforts. Use of both the OCI and CMB further ocean science literacy by emphasizing the connections between the ocean and climate systems, and surpass traditional concept mapping software by connecting users directly to scientific content.

Sharing Information:
Training occurs at conferences, workshops, and during webinars.

Product Type:
Teaching aids
Product Description:
The Ocean Climate Interactive or "OCI" (http://cosee.umaine.edu/tools) is a flash-based interactive database of resources for climate and ocean science education, displayed through a graphical user interface that emphasizes connections between related concepts. The OCI interface features fundamental concepts in ocean/climate science, and related sub-concepts. Hovering over the concepts reveals arrows linking the concepts together, and inviting the user to explore multiple areas, and promoting systems thinking. It was created to help users to map ocean topics to educational standards, and bring the relevance of the oceans to classrooms, helping learners better understand the context of the oceans in both the earth and solar systems.

The OCI interface consists of three distinct "views." Each view describes relationships between the earth's climate and ocean systems at different scales: The Earth-Sun System View, Earth View, or the Close-Up View feature concepts linked to other concepts, sub-concepts, and a multitude of assets. Clicking on one of the concepts in the interactive brings the user to an overview of the topic, along with a collection of resources that they can explore to learn more. Vetted by ocean science researchers, a collection of over 2100 news articles, videos, images and teacher resources have been assembled that are available for educational use. These assets can be viewed by clicking on concepts, or through a more comprehensive search. The videos feature visualizations of fundamental science concepts (such as the water cycle, upwelling, seasons) that can contribute to student comprehension of complex science topics. Images include photographs, scientific data and explanatory graphics.

Sharing Information:
Training occurs at conferences, workshops, and during webinars.

Product Type:
Teaching aids

Product Description:
The Concept Map Builder or "CMB" (http://cosee.umaine.edu/tools) allows registered users to create their own interactive concept maps. The maps created can be printed, downloaded, shared via email, and displayed in the OCI presentation window. What makes the CMB different than traditional concept map building software is its integration with the OCI database. This allows users to supplement each concept with multimedia assets that are displayed in the OCI interface. It is through this relationship that learners can create concept maps that illustrate ocean climate connections, as well as give educators tools to create lesson plans, presentations or multimedia collections to supplement their curriculum.

Traditionally, concept mapping has been used in formal education as an assessment tool. However, COSEE-OS has found that that collaborative concept mapping catalyzes peer-based dialogue, promotes understanding of and consensus around scientific concepts, and is very suited for application to complex and system-scale science. Concept maps can also be used for curriculum development, as presentation aids, and for project planning (e.g., proposal and thesis preparation). Educators and scientists who have participated in SEC workshops have often gone on to use concept mapping in many other unanticipated and novel ways.

Since launching in 2008, more than 1100 concept maps have been created by registered users. The number of maps created each month has increased four-fold since launch, with an average of 63 maps produced each month in 2010.

Sharing Information:
Training occurs at conferences, workshops, and during webinars.

Product Type:
Teaching aids

Product Description:
COSEE-OS is leading efforts to redesign COSEE.net, including its database architecture and Content Management System. COSEE-OS is also building tools, databases, and design elements to support the newest COSEE Centers and existing Centers that are planning to redesign their websites.

Sharing Information:
The COSEE.net redesign effort is being vetted through the COSEE Web Working Group which has representatives from the vast majority of Centers.

Contributions

Contributions within Discipline:
In Year 5, COSEE-OS has contributed to Network-related meetings and groups contribute within the project's disciplines:
- COSEE Evaluation Working Group, Scientist Engagement Working Group, Web Working Group;
- COSEE Ad hoc Professional Development Committee; and
- Participation in New England Ocean Sciences Education Collaborative (NEOSEC) through working group telecons and in-person meetings.

Contributions to Other Disciplines:
Like in previous years, COSEE-OS and has received substantial benefit, such as broader visibility in earth & space sciences community, from the project PI's other role as Education & Public Outreach manager for the NASA mission Aquarius (to measure ocean salinity).

Contributions to Human Resource Development:
COSEE-OS is testing the impact of our activities with 'non-traditional' users of ocean education materials: inland / 'landlocked' and rural audiences. In Year 5, COSEE-OS has captured the interest of educators and students who are not science majors, and also provided exposure to science and technology for pre-college teachers. Preliminary evaluation data indicates that continued training in concept-centered teaching and learning techniques will continue to make positive impacts on university faculty, research scientists, and classroom teachers alike.

Contributions to Resources for Research and Education:
Already described as part of 'Project activities.'

Contributions Beyond Science and Engineering:

Conference Proceedings

Categories for which nothing is reported:
Contributions: To Any Beyond Science and Engineering
Any Conference
PROJECT ACTIVITIES

Initiated in 2005, the Centers for Ocean Sciences Education Excellence (COSEE) - Ocean Systems (OS) has served as the National COSEE Network’s research and development (R&D) incubator for tools to engage scientists and educators in collaborative activities, specializing in online technology to achieve broader impacts. As a thematic center with the goal of fostering substantive scientist-educator collaboration, COSEE-OS has met or surpassed all of its expected outcomes -- educator-researcher team building, “showcasing” the ocean’s role in the earth system through interactive multimedia, evaluating and identifying high quality teaching resources, and developing a transferrable workshop model for effective use of ocean content -- all in direct support of the Network. In addition, OS has honed its R&D of effective tools and techniques within a creative team atmosphere that embraces formative assessment at all scales: from individual user feedback on software functionality to external evaluation of the Center’s overall effectiveness and impacts. Appendix A has a list of presentations, posters, workshops and short courses given by COSEE-OS.

Scientist-Educator Collaboration at the Center of COSEE-OS

As with all COSEE-OS activities, the “Kickoff” meetings involved one-on-one interaction between educators and researchers, working towards targeted outcomes. For example, Center employed “Ocean Literacy” (OL) activities that were enlightening for educators and scientists alike; an outcome of these activities was selection of the “top” OL principles to be highlighted in COSEE-OS products. This prioritization set the stage for subsequent “concept map” training sessions for scientists and educators in winter 2005-2006 (Fig. 1). The consensus-based concept maps during these sessions provided a solid foundation for COSEE-OS multimedia designers to design a web-based user interface that provides access to a “virtual journey” through the ocean-climate system, relevant publications, reviewed educational resources, and more (Fig. 2). Another key outcome of the initial “Kickoff” meetings was beginning the rigorous documentation of user requirements for online interactive tools.

Four COSEE-OS sponsored UMaine workshops, *Teaching Science by Ocean Inquiry*, were held in summers 2006-2008 at the Darling Marine Center. The instruction team included faculty in the School of Marine Sciences (Boss and Karp-Boss) and College of Education (Weller). The workshops were designed for in-service teachers and explored the dynamics of teaching science using ocean examples. The goals were to: 1) help teachers develop inquiry-based units for teaching physical concepts (e.g., density, buoyancy, forces, and waves) using oceans and their climate links as a vehicle; and 2) develop a network between teachers, scientists and experts in education. During the workshop, teachers worked
closely with the instructors to develop hands-on activities, teaching materials, and means of assessment to address educational standards.

The summer educator workshop was complemented by the semester course, *Teaching Physical Sciences by Ocean Inquiry* held at UMaine in Spring 2007 and 2008 (Fig. 3). These courses provided unique opportunities for marine science students who were interested in incorporating an educational aspect to their science backgrounds and also for education majors who wanted to learn about marine sciences. Instructors utilized an inquiry-based instructional approach to learn sciences content and relevant ocean examples that could be used to illustrate them. The science content was balanced with relevant pedagogical strategies that are commonly used to teach science concepts (e.g., rich question-eliciting environments, discrepant events, student prediction and initial exploration, generating hypotheses, teaching measurements, etc.).

Along with piloting its own workshops, COSEE-OS worked closely with University of New Hampshire (UNH) and the Gulf of Maine Ocean Observing System (GoMOOS) to improve scientist-educator collaboration in their summer institutes from 2006 to 2008 (Fig. 4). The 2007 institute, *Climate and Oceans - Using Ocean Based Data*, was conducted in partnership with the Monterey Bay Aquarium Research Institute program EARTH (Education and Research: Testing Hypotheses), a professional development program that uses real time ocean observing data for teachers in the classroom. In addition to providing software beta-testing opportunities, the UNH/GoMOOS workshops provided an important venue for initial testing the use of concept maps to foster peer-to-peer collaboration between scientists and K-12 educators.

A key COSEE-OS publication, *Online Tools Help Get Scientists and Educators on the Same Page* (deCharon et al., 2009), was based a field-test case study conducted during the UNH July 2008 institute for educators. At the institute, five ocean scientists provided traditional presentations about their research, and with support from COSEE-OS staff they also created concept maps outlining their talks. Prior to the workshop, staff and scientists worked collaboratively to clarify and distill the scientists’ messages for the audience of educators. Center staff also asked the educators who attended the workshop to construct a series of concept maps that began with their pre-workshop understanding of seasonal change in the ocean and that were refined based on daily talks by scientists. These maps were constructed online using COSEE-OS tools, and scientists were able to see concrete examples of how individual educators translated their science messages into classroom-ready materials.
**Enhancing Collaboration through Development & Testing**

Figure 5 depicts the major initial activities of COSEE-OS: “concepts” colored in yellow summarize the early scientist-educator collaborations that were described in the previous section. These collaborations resulted in specific products (blue concepts) and a process model, Scientist-Educator Collaborative Workshops (orange concept).

The *Teaching Science by Ocean Inquiry* summer workshops and UMaine semester courses resulted in two outputs: (i) the 52-page booklet *Teaching Physical Concepts in Oceanography: An Inquiry-Based Approach* (Karp-Boss et al., 2009) as a supplement to *Oceanography* magazine; and (ii) a UNH course, *Exploring Informal Science Education Through Ocean Inquiry*, that was co-instructed by ocean science and education faculty in Spring 2010. The booklet has become a “staple” in outreach efforts for the COSEE Network, particularly at ocean sciences conferences such as the American Geophysical Union. Ellen Kappel, *Oceanography* editor has noted: “The booklet is by far our most popular download” (pers. com., 2010). It is available in English, French, Spanish and Catalan on the *Oceanography* website (http://tos.org/hands-on/teaching_phys.html) and COSEE-OS hosts a series of associated instructional videos on its website (http://cosee.umaine.edu/programs/courses/UMaine491/).

Cycles of development, testing and user feedback have allowed OS tools to keep pace with the growing needs of scientists and educators. Scientists worked with COSEE-OS to design the Ocean Climate Interactive (OCI) user interface (Fig. 6) in 2005-06 using consensus-based concept mapping as a framework for its design (Fig. 2). Subsequently, extensive beta testing by dozens of scientists and formal and informal educators led to the development of the Concept Map Builder (CMB). Both the OCI and CMB have been extensively tested in COSEE-OS workshops, resulting in periodic releases of new software versions with additional features or enhancements. All COSEE-OS workshop evaluations include specific questions about tool usefulness and features: users’ suggestions for further improvements are invited and then subsequently reviewed by OS to determine the direction of subsequent software development.
The OCI (http://cosee.umaine.edu/climb/oci/) includes a database of resources for climate and ocean science education, displayed through a Flash-based graphical user interface that emphasizes connections between related concepts. The OCI interface features fundamental concepts in ocean/climate science, and related sub-concepts. Hovering over the concepts reveals arrows linking the concepts together, and inviting the user to explore multiple areas, and promoting systems thinking. It was created to help users to “map” ocean topics to educational standards, and bring the relevance of the oceans to classrooms, helping learners better understand the context of the oceans in the earth and solar systems. The OCI interface (Fig. 6) consists of three distinct views -- Earth-Sun System, Earth, and Close-Up -- each with its own concepts. Clicking on any of the concepts brings the user to an overview of the topic, along with a collection of assets that they can explore to learn more. Whereas the OCI concept maps are preset, the CMB (http://cosee.umaine.edu/climb/cmb/) allows registered users to create their own interactive concept maps. The products created can be printed, downloaded, and shared via email. Users can use the CMB for a variety of purposes including delivering content online and creating visual organizers for planning curriculum, projects or proposals.

Vetted by ocean and library scientists on staff, a large collection of images, news articles, videos, images and teacher resources have been assembled that are linked to the OCI and CMB (Table 1). These “assets” can be viewed by clicking on concepts, or through a more comprehensive search. Videos include visualizations of fundamental science concepts that can contribute to student comprehension of complex science topics. Images include photographs, scientific data and explanatory graphics.

After the launch of Version 1.1 of the OCI and CMB in January 2008, the reach and use of COSEE-OS tools increased steadily over time. Version 1.2 of the software included the ability to save, share, and print custom concept maps. Version 1.5, released in January 2010, allowed users to search the database and save a “library” of assets that could be linked directly to concepts, connect maps together with hyperlinks, preview assets attached to concepts and easily edit concept attributes. At that time, there were 665 registered users who had made 1533 maps (Fig. 7).

In concert with iterative software development, COSEE-OS has developed a model of Scientist-Educator Collaborative (SEC) workshops; these interactions are designed to use consensus-based concept mapping to increase the capacity of scientists and educators to effectively communicate. Although nearly all of the 102 educators who applied to participate in SEC workshops were familiar with concept mapping, only one of the 20 participating scientists had previous experience with the technique. This prompted the inclusion of half-day scientist training sessions to prepare them for focused concept mapping with educators the following day.

SEC workshops follow a non-traditional “peer-to-peer” model of interaction between educators and scientists (Fig. 8). In many scientist-educator interactions, the scientist is considered to be the expert while the educator is primarily considered to be a recipient of science content. Educators, in this scenario, have little to...
Contribute to the scientist's knowledge base. In the SEC model, scientists and educators are considered to be experts in their own area. Both groups believe they have something to learn from each other, leading to a mutually beneficial collaboration. In SEC workshops, scientists contribute rigorous content knowledge resulting from their scientific training. Educators likewise contribute rigorous pedagogical expertise, including information about conceptually “deconstructing” complex science to meet the needs non-scientists.

An important component of SEC workshops is the quantitative method developed by COSEE-OS to match workshop applicants with scientists using Ocean and Climate Literacy Essential Principles as a framework (National Geographic Society et al., 2005; NOAA et al., 2008). For each workshop, the set of principles that best align with the scientists’ research areas are included in application surveys. During the application process, potential participants rate their comfort with specific principles, along with relevance to their teaching or research situations. When matching individual participants with principles (i.e., as a proxy for specific scientists), priority is placed on those with which participants are least comfortable. Conversely, the higher a participant rates a principle's "relevance," the more likely s/he will be matched with the associated scientist.

Flexibility is a key attribute of the SEC model: it allows shorter and longer versions depending upon the venue and participants’ needs (e.g., scientists, educators, graduate students). SEC workshops have been fully documented online (Fig. 9) with information on each participant, concept maps describing the “evolution” of ideas through the workshop, facilitation process descriptions, evaluation data, and participants’ reflections. Such documentation aided in implementation of variations of the SEC model at other COSEE Centers: Coastal Trends, Pacific Partnerships, California, West, and NOW.

**Implementation & Deployment of Mature Products and Models**

Figure 10 depicts major late-stage activities of COSEE-OS. Green concepts highlight two models that were developed based SEC workshop feedback: (i) Research-based Online Learning Event (ROLE) model webinars and blogs; and (ii) Faculty-Graduate Student collaborative workshops. Purple concepts depict how separate software tools (OCI and CMB) were merged into the Concept Linked Integrated Media Builder (CLIMB) that includes the Public Maps as a way to broadly share knowledge.

Figure 9: Web documentation of workshop held at the University of Connecticut (October 2009)

Figure 10: Purple and green concepts depict late-stage COSEES-OS products (squares) and processes/models (circles)
In post-event interviews with scientists who have been trained to “deconstruct” their science (Appendix B), a frequent recommendation is training graduate students in concept mapping. In response, COSEE-OS augmented its peer-to-peer SEC collaboration model with a “mentor-mentee” model: Faculty-Graduate Student Collaborative (FGSC) workshops. In this model, one group is more experienced than the other but both groups are interested in learning how to effectively share their content with non-scientists. While both the research faculty and graduate students possess scientific knowledge, they have varied levels of experience relating their content to others. The introduction of a third-party audience during the workshop (e.g., high school students, undergraduates) provides the less experienced graduate students an opportunity to step into the “expert” role and receive feedback for their own skill development. Partially funded by the American Recovery and Reinvestment Act funds, FGSC workshops have been (or will be) held at COSEE-OS, COSEE West, COSEE NOW and COSEE California (Fig. 11).

In Summer 2010, COSEE-OS debuted the ROLE model webinar series. The design of these webinars was largely based on feedback from the “2009 COSEE-OS Educators Survey” that indicated participants’ interests in (priority order): i) presentations from a scientist on new topics; ii) sharing how educators use concept mapping; and iii) demonstrations of new COSEE-OS software features. In addition to providing educators timely access to scientists and their ongoing research, these webinars provide scientists a chance to interact with educators while presenting their research in a non-traditional format - through multimedia concept maps and post-webinar blogs. Unlike traditional linear slide-based presentations (e.g., PowerPoint), these dynamic concept maps can be explored with an audience and give “big picture” context to the scientific research. The concept maps presented are linked to educational assets from the COSEE-OS database (Table 1) that webinar participants can use in their own educational practices, presentations or for their own learning. The webinars have also been integral to infusing cutting-edge research content to the COSEE-OS database. Archives of the 10 ROLE model webinars that have been conducted through June 2011 are available at http://cosee.umaine.edu/programs/webinars/rolemodel/. Through these types of online interactions, participants from diverse geographic areas have an opportunity to directly interact with research scientists and to connect with other educators outside their own educational settings. Figure 12 shows the 28 states (and District of Columbia) from which the 265 participants accessed the live ROLE model webinars. In addition, GoogleAnalytics data indicate that during the last year, about 6.7% (totaling 4359) of all COSEE-OS website page views were related to the ROLE model webinars, including archived webinar content.
COSEE-OS workshop and webinar model development is highly integrated with the evolution of its software tools. Based on years of user feedback, the OCI and CMB were recently merged into CLIMB. This version (1.6) allows users to create folders, preview maps in a list, and instantly share maps with others. CLIMB also includes the option to make maps “public.” Vetted by COSEE-OS staff members, Public Maps are searchable, sortable, and available for copying to personal profiles. The revamped concept map presenter allows users to toggle concepts on/off by color and dynamically zoom in/out of maps. Figure 13 shows the overall growth in CLIMB registered users and maps created (2180 and 5018, respectively) from January 2008 through July 2011. With the COSEE-OS renewal funding in October 2010, user feedback continues to be collected on version 1.6 to set requirements for future software tools.

**New Initiatives Stemming from COSEE-OS Activities**

Center activities have launched several new initiatives, some of which have been funded by other sources. Five such examples are shown at right in Figure 14. CLIMB tools are now being adapted to search the semantic web for the Ocean Observatory Initiative (OOI) efforts. COSEE-OS and its new partners, the Institute for Broadening Participation, are working with Ocean Learning Communities to implement the Pathways webinar series to address increasing diversity in ocean sciences. The North Atlantic Bloom (NAB) webinar series is the realization of the “Broader Impacts” component of the NAB research proposal to the National Science Foundation. COSEE-OS worked with faculty-level scientists and post-
docs at Bigelow Laboratory for Ocean Sciences (Nicole Poulton), University of Maine (Mary Jane Perry, Ivona Cetinic), University of Washington (Eric D’Asaro, Craig Lee), and Woods Hole Oceanographic Institution (Amala Mahadevan, Melissa Omand) to capture and share their research. In addition, each webinar session featured specific teacher-friendly datasets based on data collected during NAB cruises. Shortly before the June 2011 launch of NASA’s first instrument to measure sea surface salinity, the SEC workshop model was held at the Jet Propulsion Laboratory (JPL). The *Aquarius JPL workshop* featured 5 JPL scientists and 52 educators: this event successfully tripled the number of educators in any previous SEC workshop, thus demonstrating the scalability of the model. The most recent iteration of the SEC collaboration model is the *Curriculum Development Workshop* that includes graduate student-developed data sets and “hands on” demonstrations to build their confidence in “bridging the gap” between marine sciences faculty and pre-college educators; piloted in July 2011 at Colby College, this four-day workshop model also provides educators a full framework of content, data, and activities that can serve as a foundation for curriculum development.

**References**


APPENDIX A

COSEE-Ocean Systems: Presentations, Posters, Workshops & Short Courses
A map showing the locations of these events and links to web pages about specific activities is available at http://cosee.umaine.edu/events/onthemove/

Presentations

Research-based Online Learning Event (ROLE) Model Webinar: Karen Orcutt and Kjell Gundersen: Deepwater Horizon Oil Spill: The True Role of Microbes (23-Mar-11) - online

Research-based Online Learning Event (ROLE) Model Webinar: Rick Wahle: Lobster in the Gulf of Maine - From Hatch to Catch (16-Feb-11) - online

Responsive, Flexible and Scalable Broader Impacts (15-Dec-10) - AGU Fall Meeting, San Francisco, CA

Capitalizing on Education and Outreach (E&O) Expertise to Broaden Impacts (15-Dec-10) - AGU Fall Meeting, San Francisco, CA

Research-based Online Learning Event (ROLE) Model Webinar: Fei Chai and Jenny Albright: Climate Change, Carbon Cycle, and the Role of Iron (01-Dec-10) - online

Research-based Online Learning Event (ROLE) Model Webinar: Linda Kalnejais and Sharon Gallant: Excess Nutrients in Estuarine Systems (17-Nov-10) - online

Tools for Learning about Ecosystem Diversity: Concept Mapping Interdisciplinary Science Topics (12-Nov-10) - NEOSEC 2010 Ocean Literacy Summit, University of New Hampshire

Research-based Online Learning Event (ROLE) Model Webinar: Carolyn Jordan and Kate Leavitt: What’s in a Model? Exploring Climate Aerosols (03-Nov-10) - online

Research-based Online Learning Event (ROLE) Model Webinar: Benjamin Twining and Annette deCharon: Melting Icebergs: Study Methods, Dynamics & Impacts (20-Oct-10) - online

Research-based Online Learning Event (ROLE) Model Webinar: Lawrence Mayer and Beth Campbell: Sequestered Carbon and the Carbon Cycle (06-Oct-10) - online

Research-based Online Learning Event (ROLE) Model Webinar: Penny Vlahos and Sue Klemmer: Persistent Organic Pollutants (22-Sep-10) - online

Research-based Online Learning Event (ROLE) Model Webinar: Peter Girguis and Louise McMinn: Hydrothermal Vent Ecosystems (08-Aug-10) - online

Research-based Online Learning Event (ROLE) Model Webinar: Kjell Gundersen & Karen Orcutt: Gulf of Mexico Impacts & More (28-Jul-10) - online

Graduate Student Webinar (02-Jun-10) - online

Sharing of COSEE-OS Graduate Student Workshop Experience (10-May-10) - School of Marine Sciences Annual Graduate Student Symposium, Darling Marine Center, Walpole, ME

Interactive Tools for Creating Ocean and Climate Science Connections (31-Mar-10) - Society for
Information Technology & Teacher Education International Conference, San Diego, CA

**Scientist-Educator Partnerships to Enhance Rural Ocean Literacy** (20-Mar-10) - National Science Teachers Association Meeting, Philadelphia, PA

**Using Concept Maps To Teach Biological Oceanography** (24-Feb-10) - 2010 Ocean Sciences Meeting, Portland, OR

**Baiting the Hooks: Scientist-Educator Team Development Through Concept Mapping and Online Tools** (24-Feb-10) - 2010 Ocean Sciences Meeting, Portland, OR

**Meeting Ocean Scientist’s Needs to Improve the Communication of Their Science Research: What COSEE-OS Has Learned** (23-Feb-10) - Ocean Sciences Meeting, Portland, OR

**Online Tools Help Get Scientists and Educators on the Same Page** (18-Jan-10) - COSEE-Alaska Communicating Ocean Sciences Workshop, Anchorage, AK (P)

**Scientist - Informal Educator Collaborative Workshops: Overview** (15-May-09) - New England Ocean Sciences Education Collaborative Governing Council Meeting, Portsmouth, NH

**COSEE: The Oceans, They are A-Changin’: How Might This Affect You?** (21-Mar-09) - National Science Teachers Association National Conference, New Orleans, LA

**Climate Concepts: Meshing Cutting-Edge Research With Education** (07-Nov-08) - 2008 New England Ocean Sciences Education Collaborative Ocean Literacy Summit, Boston, MA

**COSEE-OS: Concept-Mapping Web Tools Put Ocean-Climate Resources at Your Fingertips** (21-Jul-08) - National Marine Educators Association Conference, Savannah, GA

**Overview of COSEE-OS Ocean-Climate Interactive, Concept Map Builder & Concept-Linked Integrated Media Builder** (16-May-08) - New England Ocean Sciences Education Collaborative Meeting, Rye, NH

**Review Status of COSEE.net: Building a COSEE Web** (30-Apr-08) - COSEE Network Meeting, Catalina, CA

**COSEE-Ocean Systems: Investigating Climate through Ocean Visualization & Inquiry** (29-Mar-08) - National Science Teachers Association National Conference, Boston, MA

**Creating Interactive Data Tools & Case Studies to Support Future Use of Satellite-Derived Salinity Data** (4-Mar-08) - American Society for Limnology and Oceanography Ocean Sciences Meeting, Orlando, FL

**Aquarius & COSEE-Ocean Systems** (06-Dec-07) - Maine Mathematics and Science Alliance "Climate Change and Technology" Conference, South Portland, ME

**Building the COSEE Web Presence** (07-Nov-07) - COSEE Council and National Advisory Committee Meeting, Washington, DC

**COSEE-OS: Teaching Science by Ocean Investigation** (25-Jul-07) - National Marine Educators Association Conference, Portland, ME

**Best Education / Outreach Practices from Observing Systems: Applications to the Great...**
Lakes and GLOS (10-Apr-07 through 11-Apr-07) - Great Lakes Observing System (GLOS) Symposium, Traverse City, MI

Marine Sciences Education & Outreach: Past, Present and Future (09-Feb-07) - University of Maine School of Marine Sciences Seminar, Orono, ME

Investigating the Ocean-Climate System, Concept by Concept (14-Dec-06) - American Geophysical Union Fall Meeting, San Francisco, CA


This Just In: Relating Cutting-Edge Research to OSL Principles (04-Nov-06) - 2006 New England Ocean Sciences Education Collaborative Ocean Science Literacy Summit, Boston, MA

Enhancing Student Learning in Science With Digital Resources (12-Oct-06) - Maine Mathematics and Science Alliance, South Portland, ME

COSEE-OS Overview (30-Jan-06) - NASA Earth Science Education Team Meeting, Washington, DC

Posters (*indicate posters presented by graduate students)

Interactive Tools for Creating Ocean and Climate Science Connections (31-Mar-10) - Society for Information Technology & Teacher Education International Conference, San Diego, CA

*Exploring Informal Science Education Through Ocean Inquiry (25-Feb-10) - 2010 Ocean Sciences Meeting, Portland, OR

*A Common Ground for Effective Science (24-Feb-10) - 2010 Ocean Sciences Meeting, Portland, OR

*Regeneration in the Classroom: Linking Infaunal Injury and Ocean Literacy Using Integrated Concept Mapping (03-Jan-10) - Society for Integrative and Comparative Biology Annual Meeting, Seattle, WA

Workshops and Short Courses

Scientist/Educator Collaborative Workshop at JPL (03-Jun-11 through 04-Jun-11) - NASA/Jet Propulsion Laboratory, Pasadena, CA

Graduate Student / Faculty Collaborative Workshop at Rutgers (11-May-11 through 12-May-11) – Rutgers University, New Brunswick, NJ

High School Girls Learn Research Methods at the Darling Marine Center (08-Apr-11 through 09-Apr-11) - Darling Marine Center, Walpole, ME

Scientist/Educator Collaborative Workshop at JPL (03-Jun-11 through 04-Jun-11) - NASA/Jet Propulsion Laboratory, Pasadena, CA

Graduate Student / Faculty Collaborative Workshop at USC (04-Apr-11 through 05-Apr-11) – University of Southern California, Los Angeles, CA
**COSEE-OS Broader Impacts Workshop** (24-Mar-11) - Seacoast Science Center, Rye, NH

**RIDGE 2000 Workshop: COSEE-OS Helps With Education and Outreach** (29-Oct-10 through 31-Oct-10) - Ridge 2000 (R2K) Community Meeting, Portland, OR

**Earth, Air, Water and Fire: Multi-Media Concept Mapping to Promote Ocean Literacy in Rural and Inland Audiences** (21-Jul-10) - 2010 NMEA Conference, Gatlinburg, TN

**Scientist-Educator Partnership Program Orientation at COSEE-Coastal Trends** (24-Jun-10 through 26-Jun-10) - University of Maryland's Horn Point Laboratory, Cambridge, MD

**Building Educator-Scientist Partnerships through Digital Concept Mapping** (02-Jun-10) - University of Maine

**Informal Educator-Scientist Collaborative Workshop** (24-May-10 through 26-May-10) - California Polytechnic State University, San Luis Obispo, CA

**Graduate Student / Faculty Collaborative Workshop** (29-Jan-10 through 02-Feb-10) - Darling Marine Center, Walpole, ME

**Educator-Scientist Collaborative Workshop** (8-Oct-09 through 10-Oct-09) - University of Connecticut Avery Point Campus, Groton, CT

**Informal Educator-Scientist Collaborative Workshop** (01-Jun-09 through 03-Jun-09) - Seacoast Science Center, Rye, NH

**COSEE: The Oceans, They are A-Changin’: How Might This Affect You?** (20-Mar-09) - National Science Teachers Association National Conference, New Orleans, LA

**Educator-Scientist Concept Mapping Workshop** (13-Mar-09 through 14-Mar-09) - New England Center, Durham, NH

**Educator-Scientist Climate Change Workshop** (22-Nov-08 through 23-Nov-08) - Darling Marine Center, Walpole, ME

**COSEE-OS: Concept-Mapping Web Tools Put Ocean-Climate Resources at Your Fingertips** (08-Oct-08) - Maine Science Teachers Association Fall Conference, Gardiner, ME

**COSEE-Ocean Systems Online Tools** (Jul-08) - NOAA Workshop: Earth as a System is Essential, Rye, NH

**Investigating the Ocean-Climate System, Concept by Concept** (Jul-08) - COSEE-OS Workshop: Teaching Sciences by Ocean Inquiry, Walpole, ME

**COSEE-OS: Teaching Sciences by Ocean Investigation** (Jul-08) - Educators Institute: Understanding Seasonal Change in the Ocean Using Ocean Observing Data, Durham, NH

**COSEE: Salting Away for Our Future: Resources for Understanding the Ocean's Role in Climate Change** (28-Mar-08) - National Science Teachers Association National Conference, Boston, MA

**Investigating the Ocean-Climate System, Concept by Concept** (26-Jul-07) - COSEE-OS Workshop: Teaching Sciences by Ocean Inquiry, Walpole, ME

**Geosciences Centers and Facilities Education and Outreach Workshop** (13-Mar-07 through 14-
Mar-07) - National Science Foundation, Arlington, VA

**Digital Library for Earth System Education (DLESE)** (23-Feb-07) - Resource Review Process Meeting, Darling Marine Center, Walpole, ME

**COSEE-OS Overview** (10-May-06) - Climate Variability and Predictability (CLIVAR) - NASA Aquarius / SAC-D Workshop, Falmouth, MA

**Education and Research: Testing Hypotheses (EARTH)** (10-Jul-06 through 14-Jul-06) - COSEE Mid-Atlantic Conference: Taking the Pulse of the Ocean, New Brunswick, NJ

**COSEE-OS Overview** (23-Jan-06) - NASA Aquarius Education and Public Outreach Focus / Advisory Group Meeting, Denver, CO
APPENDIX B

Scientists Who Received Concept Mapping Training from COSEE-OS or its Partners
Also available online at http://cosee.umaine.edu/coseeos/forscientists/scientists.htm

North Atlantic Bloom Webinar Series (July - August 2011)

Mary Jane Perry  Amala Mahadevan  Eric D’Asaro  N. Poulton & I. Cetinic  Craig Lee

Curriculum Development Workshop at Colby College (July 2011)

Damian Brady  William Ellis  Jeffrey Runge  Rebecca Van Beneden  Rhian Waller

Aquarius Workshops & Public Webinar (Spring 2011)

Felix Landerer  Tony Lee  Dimitris Menemenlis  Josh Willis  Victor Zlotnicki
Yi Chao  Gary Lagerloef  Jorge Vazquez  Will Hobbs

Faculty-Graduate Student Collaborative Workshop – Rutgers University (May 2011)

Debashish Bhattacharya  Lee Kerkhof  James Miller  Oscar Schofield  Elisabeth Sikes
Pathways Webinar Series (May 2011)

Faculty-Graduate Student Collaborative Workshop – University of Southern California (April 2011)

ROLE Model Webinars

Scientist-Informal Educator Collaborative Workshop – Cal Poly San Luis Obispo (May 2010)
PROJECT FINDINGS

Early Scientist-Educator Collaborations & Workshops

Held during the first eight months of the project, three “Kickoff” meetings in Brunswick (Maine) set the stage for future COSEE-OS facilitated interactions between educators and researchers. The first kickoff meeting included 16 participants from ocean science and education research institutions, pre-college educators, and informal educators. Education researchers introduced a suite of pedagogical strategies and techniques -- including concept mapping -- to 12 participants during the second meeting. With seven participants, the third meeting was a focused effort to pilot concept mapping as a technique to facilitate communication between scientists and educators. For all of the “Kickoff” meetings, participant selection was designed to achieve an equal balance between scientists and educators thereby ensuring that the needs of both groups would be met. Figure 1 compares the normalized data from these early meetings and shows that all participants were either very satisfied or satisfied with the overall meetings.

An important outcome of the kickoff meetings’ findings (Fig. 2) was setting the priorities for subsequent COSEE-OS work. The first two meetings included presentations and activities on ocean literacy, background information on adults’ science content knowledge and misconceptions. The second kickoff
meeting’s evaluation data (red bars in Fig. 2) showed a stronger preference for concept mapping (right graph) compared with the other approaches (left graph). The enthusiasm for concept mapping was also apparent in participant comments provided by scientists—e.g., “I’ve begun to think more about how to communicate these concepts to students in integrated ways”—and educators—e.g., “I love learning from how scientists think and how to present complex concepts to students.” In their evaluation for Kickoff #2, three scientists wrote that they would be willing to participate in future concept-mapping exercises (even though they were not directly asked about their interest in doing so).

Thus the third kickoff meeting focused on concept mapping as the primary tool to foster scientist-educator collaboration. Group discussions and post-meeting evaluation data (Fig. 2, right graph) indicated that participating researchers and educators agreed that concept mapping was an effective educational tool to help non-scientists learn about the ocean-climate system. COSEE-OS staff observed scientists stepping back from their focused research interests and considering a more “big picture” view of what students should know about the ocean. Educators were pleased that the Center was employing a strategy that was both familiar and practical to their expertise. In addition, thanks to its direct application to interactive media development, the concept mapping approach was straightforward in achieving the Center’s goal of highlighting oceans in the Earth-Sun system using online tools.

An important finding from this series of meetings was the increase in understanding of the COSEE-OS objectives over time (Fig. 3). The more COSEE-OS focused on specific approaches to collaborative development, the clearer its objectives became to the target audiences of scientists and educators. Being among the first thematic Centers in the COSEE Network, it was important to foster dialogue not only about ocean sciences but also about pedagogy, practice, and learning processes. By building an understanding and appreciation of these issues among its stakeholders, COSEE-OS was able to create a strong research-based foundation for piloting models to foster mutually beneficial interactions between scientists and educators.

The Teaching Sciences by Ocean Inquiry summer workshop was held in 2006 and 2007 for in-service teachers who explored the dynamics of teaching science using ocean examples. In the 2006 session, daily and summative questionnaires provided the data for an evaluation report (Sheila Pendse, 2006) that concluded the workshop was “a very positive experience for all participants.” The 2007 workshop evaluator, Lori Smith, also conducted follow-up interviews with 2006 participants (i.e., 18 months after the workshop). Smith found that, based on the 2006 workshop assessment, 66% of participants stated that they have made changes to curricula content, 92% stated that they have made changes in their instructional strategy, and 75% stated that they shared knowledge gained from the workshop with other colleagues. For the 2007 session, Ms. Smith has provided an analysis of data gathered prior to and at the end of the workshop. All twelve of the respondents indicated that they would change at least some of their teaching approach / strategies as a result of participating in the workshop. The lab activities were frequently mentioned as the impetus for potentially changing their teaching approach / strategies. Likewise, the “hands on” activities were frequently cited as the “most satisfying aspect” of the
workshop. Participants were asked in what way(s) their workshop experience could have been improved. Several respondents commented that they would have benefited from more pedagogical discussions. Most respondents appreciated the course content and structure; however, two commented on the rapid pace at which the material was presented. Overall, respondents indicated that the 2007 workshop was successful in conveying scientific concepts related to marine sciences. They also praised the pedagogical applications that were relevant and transferable to their classrooms. Many of the findings from these evaluation studies were incorporated into the 52-page booklet *Teaching Physical Concepts in Oceanography: An Inquiry-Based Approach* (Karp-Boss et al., 2009), published as a supplement to *Oceanography* magazine.

In addition to piloting its own workshops, COSEE-OS worked closely with University of New Hampshire (UNH) and the Gulf of Maine Ocean Observing System (GoMOOS) to improve scientist-educator collaboration. In 2007, UNH collaborated with GoMOOS and COSEE-OS in a workshop coordinated with the Monterey Bay Aquarium Research Institute EARTH program. This institute was pivotal early opportunity to collect user requirements for COSEE-OS software from 20 experienced teachers who had previously attended either UNH or EARTH workshops, along with several scientists in the field of climate science. The institute’s thematic focus provided COSEE-OS direct access to teachers from whom they collect qualitative feedback on the then “pre-beta” version of the *Climate-Oceans Interactive (OCI)* and *Concept Map Builder (CMB)*. In 2008, COSEE-OS piloted its version 1.2 software at the UNH summer institute: 73% of the participants reported that the tools would help them prepare their lesson plans and 80% of the participants reported that the OCI helped them better understand the context of oceans in both the earth and solar system. The data collected and observations made during the 2008 workshop served as the basis for the publication, *Online Tools Help Get Scientists and Educators on the Same Page* (deCharon et al., 2009).

**Parallel Development of Software and Collaboration Models**

Just prior to the public release of version 1.1 of the COSEE-OS software, a beta testing phase was conducted from 27-November through 14-December, 2007. Based on a request using ocean science education listservs, the Center received 45 fully completed surveys from testers in 16 states. About half of the survey-takers were classroom educators. The other half included, among others, university faculty, informal educators, educational program directors (e.g., COSEE Center PIs). One survey goal was discovering the technical performance of the interface. Data revealed that 89% of testers experienced “Fast” or “Moderately fast” load rates despite the wide range of connection speeds (i.e., ranging from 33.4 kbps to 3957.3 kbps). Another goal was to gauge the interface’s engagement and presentation: both received very positive feedback. Beta test data on the COSEE-OS web interface navigation scheme gave development team insight to the successful features (i.e., “Subconcept links”, “Image & video gallery” and “Tabs for images/videos/etc”) and navigational elements that needed improvement: “Navigation column at right” and “Back & forward buttons.” Beta testers were also asked about the usability of other functional elements. Data clearly revealed that some tools were working better and / or more “user intuitive” than others. User feedback also exposed one “bug” – intermittent appearance of a “print” button -- that was subsequently corrected. The survey also included statements about the quality / “recommendability” of the software: 96% of participants would recommend the OCI to their colleagues and 88% would recommend it to their students. Other statements were designed to identify individuals who would be willing to serve as online testers and / or “focus group” participants for future beta test opportunities: 91% indicated interest in testing subsequent versions of the COSEE-OS interface online and 69% wanted to be informed of “focus group” testing opportunities. This initial beta-testing activity proved so informative that COSEE-OS has continued to elicit feedback from its users primarily through listservs and workshops.
An important goal for COSEE-OS model workshops is to foster high-quality interactions between scientists and educators through the use of concept mapping and its interactive software tools. 91% of participating educators (n=53) in its Scientist-Educator Collaborative (SEC) workshops agreed that concept mapping helped them think through the science topics they learned during the workshop, and 89% said that concept mapping was a helpful way to share ideas and “build a bridge of communication” with scientists (Fig. 4). In post-workshop interviews, an equally high percentage of participating scientists agreed that concept mapping helped them share their understanding of connections with educators. For many scientists, SEC workshops gave them immediate constructive feedback on the efficacy of their communication to non-science audiences. Educators, on the other hand, provided scientists an opportunity to learn about the challenges that they face integrating scientific topics into K-12 classrooms. The mutually beneficial nature of SEC workshops fostered positive interactions between scientists and educators: on average, educators (n=53) rated the quality of interaction 6.7 on a 7.0 Likert-type scale.

During the model workshops, both formal and informal educators provided feedback about the usefulness of the OCI and CMB for: finding good education resources, helping create good lessons and/or presentations, and helping their students understand and make connections between ocean and climate concepts (Fig. 5). Based on evaluation data from SEC workshops, COSEE-OS has demonstrated that collaborative concept mapping catalyzes peer-based dialogue, promotes understanding of and consensus around scientific concepts, and is very suited for application to complex and system-scale science. Post-SEC workshop evaluation -- including telephone interviews of scientists and annual surveys of scientists and educators -- reveal that participants have used COSEE-OS tools for curriculum development, as presentation aids, and for project planning.

Center efforts towards “scientist professional development” may have contributed to the high level of participation by scientists (81%; n=25) who had participated in COSEE activities during 2009. 32% of these scientists had been involved with COSEE-OS as “resource providers” and 20% as “advocates” or “advisors” to OS, while the vast majority (92%) were involved as “participants” in Center programs and activities. Most of the survey respondents identified their field as “Oceanography” (80%). Other well-represented fields included “Aquatic Science” (52%), “Marine Biology” (48%), and “Earth Science” (30%). Of these scientists, 72% stated that OS online tools have been “Useful” to “Very Useful” in their efforts and 88% stated that they are “satisfied” to “very satisfied” with COSEE-OS assistance. Most were either in an early (44%) or mid-career (40%) stage of their profession, and a slight majority receive NSF funding for their research (52%). 80% receive greater than 50% of their funding from federal
sources (NSF = 36% and “other federal agency” = 44%). The majority of these scientists also work as “teachers, educators, or instructors” (80%) in a “formal education setting” (76%) such as “college” (80%), where most are not tenured (60%).

The COSEE Network also conducted a nationwide survey of educators who participated in activities in 2009. The survey was sent out to 62 COSEE-OS educators -- most of which (92%) had participated in one of the Center's SEC workshops -- and received a response rate of 40% (n=25). In the survey, educators said that, as a result of engaging with COSEE-OS, they had an opportunity to learn from science researchers (92%) or to work side by side with them (60%). Many said they had gained “techniques for teaching about the ocean” (76%); a “better understanding/knowledge about the ocean” (76%); or “new content” (68%) and “resources” (92%) for use in “teaching about/sharing regarding the ocean.” Since attending a COSEE-OS workshop, over 80% of responding educators had revisited the COSEE-OS website “a few times” or “regularly” and 60% had used COSEE-OS online concept mapping tools or techniques “sometimes” to “very often.” The majority of those who responded to the survey are employed in suburban areas (44%) or cities (48%) and teach high school (52%) or middle school (32%) science topics. They are mostly mid-career professionals with 10-24 years experience (40%) or advanced career professionals with 25+ years (40%) who have reached a master's or higher level degree (88%). Most are certified to teach at the secondary level (62%) and many have multiple certification credentials (28%).

As a thematic Center, one major goal of COSEE-OS is reaching inland and rural areas. Nearly half (48%) of the educators who participated in the Teaching Sciences by Ocean Inquiry and SEC workshops (n=125) were teaching in school districts and institutions classified as rural (25% suburban and 27% urban). Subjects taught include a diverse array of non-marine courses: biological science (21%), environmental science (18%), earth science (15%), chemistry and physics (15%), physical sciences (11%), and meteorology (2%). Thus, COSEE-OS is working with educators in a variety of science disciplines to help them incorporate ocean science content into their courses.

Figure 6 shows the 26 home states (blue) of the 204 educators who applied to Center in-person workshops, including: (i) Educator Institutes held at UNH; (ii) four sessions of Teaching Sciences by Ocean Inquiry; and (iii) four SEC workshops. These educator participants teach in 64 high schools, 27 middle schools, 3 universities and 11 informal education institutions.

Figure 6 also shows the home states (yellow and green) of the 58 faculty-level scientists (17 institutions) who were trained by COSEE-OS to create concept map-based presentations through July 2011. Red stars indicate COSEE Centers that have replicated or will replicate the Faculty-Graduate Student Collaborative workshop model, broadening its impact in the academic pipeline. During this period of time, COSEE-OS also trained 62 graduate students and post-docs.
“Match making” Scientists using Literacy “Fundamental Concepts” - In the SEC and Faculty-Graduate Student Collaborative workshop models, facilitators collect data to understand the participants’ comfort with specific topics and its relevance to them. The workshop application process is the primary vehicle used to discover educators’ and graduate students’ needs using a quantitative developed and tested by COSEE-OS. The Ocean Literacy (OL) and Climate Literacy (CL) documents (National Geographic Society et al., 2005; NOAA et al., 2008) served as the framework for creating groups of educators or graduate students to be teamed with a specific faculty member during the workshop. In advance of each workshop, facilitators chose a set of OL and/or CL “fundamental concepts” that would: 1) best fit the current research performed by the participating faculty; 2) be of most interest to workshop participants; 3) collectively provide the broadest view of the ocean-climate system; and 4) be able to be translated to the target end-audiences.

The chosen “fundamental concepts” were used as questions in online applications required for potential workshop participants:
- What is your comfort level (confidence level) with this “fundamental concept”?
- How relevant is this “fundamental concept” to your course content or work?

The answer choices are offered on a scale that ranges from “not comfortable” to “very comfortable” or “not relevant” to “very relevant.” The responses are given a numerical score (see below). To optimize the learning opportunity, priority is placed on content that applicants are least comfortable with. COSEE-OS has found that providing such “cognitive challenges” is beneficial; participants have consistently praised this strategy in workshop discussions and evaluations. Relevance is also a factor because if educators or graduate students cannot find a way to apply the new content, then learning about that topic will not likely impact their teaching or work.

<table>
<thead>
<tr>
<th>Comfort Level</th>
<th>Score</th>
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<tbody>
<tr>
<td>Very comfortable</td>
<td>1</td>
</tr>
<tr>
<td>Comfortable</td>
<td>2</td>
</tr>
<tr>
<td>Somewhat comfortable</td>
<td>3</td>
</tr>
<tr>
<td>Not comfortable</td>
<td>4</td>
</tr>
<tr>
<td>Very relevant</td>
<td>3</td>
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<tr>
<td>Relevant</td>
<td>2</td>
</tr>
<tr>
<td>Somewhat relevant</td>
<td>1</td>
</tr>
<tr>
<td>Not relevant</td>
<td>0</td>
</tr>
</tbody>
</table>

For each participant and fundamental concept, the comfort and relevance scores are combined. For example, a participant from one workshop rated an OL fundamental concept about ocean circulation as “somewhat comfortable” (3 points) and “very relevant” (3 points) with a total score of 6. Another participant rated it as “very comfortable” (1 point) and “very relevant” (3 points), resulting in a final score of 4. Facilitators used these responses to place the applicants: in this example, the applicant with a higher score of 6 (i.e., who was “somewhat comfortable”) was matched with the faculty member with expertise on ocean circulation.

At the conclusion of each workshop, participants are asked the same questions to quantify pre- and post-workshop changes in educators’ and graduate students’ comfort with and relevance of the material covered. For the SEC workshops (n=53), there was a net positive change for the 16 principles addressed: e.g., individual educators went from being “comfortable with” an OL or CL fundamental concept before a workshop to “very comfortable” afterward. For all principles covered, 58% to 89% of educators had a positive change. For nine principles, 75% or greater educators showed positive change. (The cumulative data for the Faculty-Graduate Student Collaborative workshops will be analyzed by the four participating COSEE Centers; see red stars in Fig. 6).
The scalability of OL/CL-based “match making” model for scientists and educators was recently proven in the SEC workshop held at the Jet Propulsion Laboratory (JPL). Unlike the previous SEC workshops in which each scientist was teamed with 3 educators, the Aquarius JPL workshop included teams of scientists and educators at a 1:10 ratio. The positive changes in OL and CL content covered during this workshop was very positive: e.g., 100% of educators who filled out the post-workshop survey (n=40) had improved comfort with the OL fundamental concept “The ocean has had, and will continue to have, a significant influence on climate change by absorbing, storing, and moving heat, carbon, and water” and 80% of the educators stated that the workshop scientists made this concept “more relevant” to their teaching. (See Appendix A for all OL/CL change data.) 88% of the educators plan to use the subject matter covered in the workshop and 85% plan to use the concept maps created at the workshop. 95% of these educators plan to use the web resources presented and 83% of participants thought the process of using concept mapping helped them “think through the topics they learned” during the workshop. The Aquarius JPL workshop was the first COSEE-OS event to feature the latest software version (1.6): the positive response to the updated tools was overwhelming: 98% of educators had either an “extremely positive” or “positive” experience “working with the Concept Map Builder to edit maps” (Fig. 7).

**Giving Feedback to Scientists from Local to International Scales** – Working closely with scientists, COSEE-OS has learned the value of giving specific information on the audiences’ backgrounds and their feedback on their presentations. In addition, scientists appreciate knowing the broad geographic reach associated with their participation in COSEE-OS webinar series.

COSEE-OS has worked with dozens of ocean scientists, some more than once, on how to communicate their research to specific non-scientist audiences using concept maps. After a half-day training session that begins with a report on the participants’ backgrounds (see Appendix B for one example), researchers present their concept maps to an audience of educators or graduate students. Audience members rate the scientists’ presentations on the following: communicating the “Big Picture” of their research, use of jargon, clarify of their “take home message,” and the concept map itself. After the presentations, scientists team up with participants -- in ratios as small as 1:3 or as large as 1:10 -- to spend several hours modifying their initial concept maps for a non-scientist audience. In the SEC model, after a full day of work in teams, educators present their “consensus map” to the entire group. In the Faculty-Graduate Student Collaborative model, graduate students present their own version of the map to the target end-audience (e.g., high school students) or a proxy for that audience (e.g., experts in informal education). These final presentations and the interactive concept maps are archived on the COSEE-OS website for post-workshop access. In addition, about 1-2 weeks after the workshop, the scientists are sent graphs that show the audiences’ reaction to their initial presentations (see Pages 2-6 of Appendix A for examples from JPL workshop). Invariability, the scientists specifically thank COSEE-OS facilitators for providing them such specific information about their workshop performances.
COSEE-OS has piloted the use of interactive concept maps in webinar format as another means of broadening the impact of ocean scientists. The pilot webinar featured University of Southern Mississippi scientists Kjell Gundersen and Karen Orcutt who shared concept maps relating to the Gulf of Mexico oil spill, building on content they originally created for COSEE-OS events at the 2009 National Science Teachers Association annual conference (New Orleans, LA). In addition, this pilot event featured two New England high school educators who showcased the innovative ways that they have used COSEE-OS tools and techniques in their classrooms. A total of 10 Research-based Online Learning Event (ROLE) Model webinars allowed participants from diverse geographic areas the opportunity to directly interact with research scientists and to also connect with other educators outside their own educational settings.

Many scientists who had participated in earlier COSEE-OS workshops were re-engaged through the ROLE Model webinar series (see Appendix B in the “Activities” section). In addition, COSEE-OS trained these scientists on effective practices for presenting in webinar format and writing follow-on blog posts. Pre- and post-webinar evaluation data reveals that 86% found scientist presentations "Useful/Very Useful" (n=93); 83% found educator presentations "Useful/Very Useful" (n=69); and 89% are more comfortable with science topics presented (n=92). Demographic data for the 265 participants in the ROLE Model webinars had a wide range of occupations (Fig. 8), including 15% college or university faculty or students. The success of the ROLE Model webinars prompted COSEE-OS to use this format for its “North Atlantic Bloom” (NAB) five-part webinar series in July-August 2011. Preliminary data analysis for the NAB webinars indicates that one-third of the participants were college or university scientists, including researchers from Iceland, Germany and Canada.

A key objective of future COSEE-OS work will be quantifying the factors that engage and sustain scientists in education and outreach. Dr. Peter Girguis (Harvard University) gave an invited presentation at the Fall 2010 American Geophysical Union meeting in which in identified five factors by which he uses to rate the effectiveness of education and outreach (EO) programs: (i) Effort by PI; (ii) Effort by lab; (iii) Extent of documentation; (iv) Accessiblity of documentation; and (v) Geographic impact (Fig. 9). Dr. Girguis...
emphasized that, for most scientists, engaging EO is a trade off between the investment of time and the level/quality of feedback about impact. COSEE-OS will continue to make strides in documenting these types of “lessons learned” to share with the COSEE Network and beyond.

References


APPENDIX A: Evaluation Data Summary from Scientist-Educator Collaborative Workshop held at NASA/JPL

Overall Workshop Evaluation
A total of 52 Educators participated in the workshop.

Of participants (n=40) that completed a post-workshop survey:
- 88% plan to use the subject matter covered in the workshop
- 85% plan to use the concept maps created at the workshop
- 95% plan to use the web resources presented

83% of participants thought the process of using concept mapping helped them “think through the topics they learned” during the workshop.

Usefulness of the workshop components (1-7 scale)
- Scientist presentations: 6.55
- Working with scientists' concept maps: 6.33
- Concept mapping software overview: 6.70
- Educator resources provided: 6.65
- Hands-on demonstrations: 6.74

This NASA workshop has inspired me to bring NASA content into my classroom
- Neutral 2%
- Agree 13%
- Strongly Agree 85%

I can immediately apply what I learned from this workshop to my teaching about science, technology or mathematics.
- Neutral 5%
- Agree 15%
- Strongly Agree 80%

Educators gave an average of 6.29 out of 7 that they were likely to use concept mapping in their work.

Educators rated the workshop a 6.32 out of 7 for its effectiveness in helping them to “understand how concept mapping can be used to present ocean - climate science topics.”

Ocean and Climate Literacy - Fundamental Concepts used in the workshop

The ocean has had, and will continue to have, a significant influence on climate change by absorbing, storing, and moving heat, carbon, and water.

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<tr>
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<td>80%</td>
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<tr>
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The ocean is an integral part of the water cycle and is connected to all of Earth's water reservoirs via evaporation and precipitation.

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<td>90%</td>
<td>80%</td>
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<td>More comfortable</td>
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</table>

The ocean absorbs much of the solar radiation reaching Earth. The ocean loses heat by evaporation. This heat loss drives atmospheric circulation when, after it is released into the atmosphere as water vapor, it condenses and forms rain. Condensation of water evaporated from warm seas provides the energy for hurricanes and cyclones.

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<td>75%</td>
<td>68%</td>
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<tr>
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<td>More relevant</td>
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The ocean has the capacity to absorb large amounts of solar energy. Heat and water vapor are redistributed globally through density-driven ocean currents and atmospheric circulation. Changes in ocean circulation can lead to significant and even abrupt changes in climate, both locally and on global scales.

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<tr>
<td>95%</td>
<td>83%</td>
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<tr>
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Most of Earth's water is in the ocean (97%). Seawater has unique properties: it is saline, its freezing point is slightly lower than fresh water, and its density is slightly higher.

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<tr>
<td>93%</td>
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<td>More relevant</td>
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Use of mathematical models is now an essential part of ocean sciences. Models help us understand the complexity of the ocean and of its interaction with Earth's climate. They process observations and help describe the interactions among systems.

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<tr>
<td>68%</td>
<td>60%</td>
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<tr>
<td>More comfortable</td>
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Presentation Feedback: Felix Landerer

The "Big Picture"

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<tr>
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<th>Clearly Stated</th>
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<tr>
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<td>43%</td>
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<tr>
<td>1</td>
<td>20%</td>
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Average rating was **4.15** out of **5**.

Use of Jargon

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<tr>
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<th>Appropriate</th>
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<td>0</td>
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<tr>
<td>1</td>
<td>28%</td>
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<tr>
<td>2</td>
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Average rating was **4.47** out of **5**.

Concept Map

<table>
<thead>
<tr>
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<th>Effective</th>
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</thead>
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<tr>
<td>1</td>
<td>28%</td>
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<tr>
<td>2</td>
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<td>3</td>
<td>6%</td>
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Average rating was **4.37** out of **5**.

Take Home Message

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<th>Memorable</th>
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<td>1</td>
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<tr>
<td>2</td>
<td>24%</td>
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<td>3</td>
<td>6%</td>
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<tr>
<td>4</td>
<td>0%</td>
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Average rating was **4.13** out of **5**.

Participant Comments:

“I really appreciate how hard you must have worked to speak at a level that we w/o your experience could completely follow Thank-you!”

“I think it is very usable for teachers esp. at middle and high school levels.”

“How powerful the effect of evaporation is on climate!”

“I liked that he was able to add and take away elements when relevant.”

“Good adding in sections of the map as the topic was discussed (instead of the whole map at once)”

“I liked the ending -- how can it relate to our classroom.”

“Precipitation - evaporation comparison might be fertile ground for discussions w/ students.”

“Very good connection to El Nino Weather pattern made presentation relatable.”

“I liked how both satellites were added to the map so we can see how they work together.”

“The concept map was very thorough in describing the connections.”

“Using concept map as a platform for explaining climate dynamics -- All HS students should have access to this.”

“The layering feature brought together many connections.”

“Thank you for adding the two layers in response to our questions I appreciate this.”

“Great map, I liked the way layers were added one at a time because there are many concepts involved in this story.”
Presentation Feedback: Tony Lee

**The "Big Picture"**

- **Not mentioned**: 0%
- **2**: 9%
- **3**: 4%
- **4**: 38%
- **5**: 49%

Average rating was **4.28** out of **5**.

**Use of Jargon**

- **Excessive**: 0%
- **2**: 2%
- **3**: 15%
- **4**: 26%
- **5**: 57%

Average rating was **4.37** out of **5**.

**Concept Map**

- **Unclear**: 0%
- **2**: 2%
- **3**: 9%
- **4**: 30%
- **5**: 59%

Average rating was **4.46** out of **5**.

**Take Home Message**

- **Muddled**: 2%
- **2**: 7%
- **3**: 16%
- **4**: 41%
- **5**: 34%

Average rating was **3.98** out of **5**.

**Participant Comments:**

"I teach at a middle school level -- it will take work to develop student understanding at our level -- but your work will help a lot."

"Excellent, succinct map, students can fill in w/details."

"I appreciate the organization of the presentation using the concept map and "click on" for more information."

"Amazing graphic support, Perfect delivery, very interesting"  

"Map connects appropriate concepts. Graphs & animations helped clarify."

"Connection between salinity & temp & the effect on density was made clear on the concept map and well explained at the same time."

"The animation of ocean currents was very illustrative."

"Excellent video, visual elements help a lot, especially maps, photos, diagrams."

"Visual aspects make it effective for my special ed students."
Presentation Feedback: Dimitris Menemenlis

**The "Big Picture"**

- Average rating was 4.60 out of 5.

**Use of Jargon**

- Average rating was 4.63 out of 5.

**Concept Map**

- Average rating was 4.26 out of 5.

**Take Home Message**

- Average rating was 4.26 out of 5.

**Participant Comments:**

"Tied in all components & introduced concept of ice."

"Very interested in how to design models. Students should be doing this."

"Clear presentation Straight to the point."

"He added information in his speech that helped me better understand the maps."

"The presentation did a great job at differentiating between land ice, sea ice and how they affect the ocean levels."

"The concept map was very effective and clear."

"I liked the summary of the model. The pictures helped. I think my students could connect to these observations."

"Great linking of ideas verbally."

"Good explanation of computer models. It is this lack of understanding of models that causes the public not to understand global warming."

"I liked the explanation of how models help us study the unobserved."
Presentation Feedback: Josh Willis

**The "Big Picture"**

- Not mentioned: 0%
- Clearly Stated: 83%

**Use of Jargon**

- Excessive: 0%
- Appropriate: 91%

Average rating was **4.74 out of 5.**

**Concept Map**

- Unclear: 0%
- Effective: 84%

Average rating was **4.80 out of 5.**

**Take Home Message**

- Muddled: 0%
- Memorable: 77%

Average rating was **4.66 out of 5.**

Participant Comments:

"Really engaging. Great use of map connected to resources. I think the students would almost understand everything about your presentation, even though it's above their knowledge comfort level."

"I appreciated the way you hinted at changes in weather w/o stating any strong message - helps some to think about what you are saying."

"The graphics and the "rhythm" of the presentation in conjunction with the unveiling of the different component of the concept maps."

"He broke it down and made it easy to understand climate change."

"I finally could pair previous learning AMS climate studies with a better visual - I really understood what I learned previously!"

"This is the best of the bunch. Not too many pathways & all pathways were explained."

"Yes - Excellent use of the concept map i.e. What drives the climate? Then Josh waits for audience answer THEN hits the next concept tab & there is the sun -- continues to use audience."
Presentation Feedback: Victor Zlotnicki

**The "Big Picture"**

- Not mentioned: 0%
- Clearly Stated: 9%
- 4: 39%
- 5: 52%

Average rating was **4.43** out of 5.

**Use of Jargon**

- Excessive: 0%
- 2: 2%
- 3: 13%
- 4: 24%
- 5: 61%

Average rating was **4.43** out of 5.

**Concept Map**

- Unclear: 0%
- 2: 2%
- 3: 20%
- 4: 39%
- 5: 39%

Average rating was **4.14** out of 5.

**Take Home Message**

- Muddled: 0%
- 0: 9%
- 3: 34%
- 4: 57%

Average rating was **4.48** out of 5.

**Participant Comments:**

"Good recap of prior presentation concepts & link to this concept."

"Excellent interpretation of graph. Superb explanation of El Nino Discussion of Shifting weather patterns."

"Very descriptive: oceans 'dancing' with the atmosphere."

"Fantastic breakdown / explanation of key concepts and how they work."

"Connection w/movie always affects students - they are very interested in how real life differs from movies or how they could understand a real phenomena."

"The speaker did a great job reviewing the main points of the first 4 speakers while connecting his point clearly."

"Visually the concept map made sense. It tied the pieces together."

"El Nino is a perfect illustration of the 'dance' between the ocean & weather patterns - Hemispheric weather/climate patterns are almost opposite."

"THE BEST and clearest presenter. He taught us with great humor. He WAS CAPTIVATING!"
APPENDIX B

EDUCATOR BACKGROUND INFORMATION
FOR CURRICULUM DEVELOPMENT WORKSHOP
Colby College, 18-21 July 2011 (n=17)

Where do you teach?
Maine – 12; New Hampshire – 3; Massachusetts - 2

What is your terminal degree?

In addition, applicants reported that they have teaching credentials (n=11) and have participated in other professional development workshops (n=8). Some respondents also provided other specific information:

• Completing MS this year
• NOAA teacher at sea/marine mammal abundance survey
• (M.S. in) Environmental Science
• I have a B.S in Marine Science and currently working on getting my M.S in Education
• (M.S. in) Biology and Environmental Studies
• My Ph.D. is in Science Education K-8.
• My concentration was in Curriculum and Instruction
• B.Sc. Chemistry with an Biology minor and English Minor; M.A. Secondary Science Education-Chemistry
• My certification is in Life Sciences which I received when I switched from the social services to teaching.
• Undergraduate biology / mathematics; Graduate literacy
• BS, Environmental Education; MALs, Env. Concentration
• (M.S. in) Chemistry, Biology
• UMO degree in secondary science education--Life Sciences. A large number of my science classes were ecology based.
• MS Marine Bioresources & MEd Middle School Science
• BS in PEd; MA of Middle School Ed w a concentration in science
• BS was in marine biology; MS was in life sciences
• (M.S. in) biology/marine biology/education
• MA in Earth System Science
• I have my bachelors in Environmental, Earth and Ocean Science. My post baccalaureate is in education and I am currently enrolled in a masters Program

What is your formal teaching experience?

Some applicants provided other specific information on teaching experiences including:
• AP Biology
• I am currently teaching students who are high school diploma candidates as well as students who are seeking their GED
• Engineering Camp for rising 7th grade girls.
• Earth Science, Biology, Env Science 8-12th grade
How many years have you been a formal educator?

Which of these subjects are you teaching now or have taught in the past?
How do you address ocean concepts in your classroom?

- Both are key elements for Ecology I and Environmental Science & Policies
- Thermohaline Circulation and it's connection to the Earth's Climate. ENSO and how effects the world's oceans and weather
- Climate change unit-heat transfer, causes of climate change, impacts of climate change, feedback mechanisms
- In the 6th grade Ecology unit water quality and climate change are a focus.
- In units on ecology
- Biology-History of Life, Climate formation, ocean environments, Climate change, Chemistry- pH, Climate change
- See answer above. I would say I am more of a generalist, and would use the training to be more topic specific and provide in depth experiences and opportunities for my students.
- Depends on the course as to how I approach it
- Plankton in the Gulf of Maine. I also do some meteorology and climate change studies.
- Gas dynamics in chemistry, Oceanic influences on climate
- Discussion based mostly during the ecology units. The ocean gets less time than climate change. Our focus has been mostly how changing climate impacts ecosystems.
- Mostly through density and forces in fluids
- Limited exposure- weather and climate using a system approach.
- Very briefly touch on ocean/climate topics in biology
- I teach marine biology.
- I will be teaching Marine Biology in the fall. Currently I do cover Ocean circulation and weather.

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COMFORT LEVEL and RELEVANCE OF OCEAN LITERACY PRINCIPLES

For the workshop application survey, we selected Ocean Literacy (OL) principles that best aligned with research interests of the workshop scientists. The educators who applied for the workshop rated their level of comfort with these principles. They also rated the relevance of these principles to their classrooms/programs.

Graphs show comfort and relevance data for all educators who applied for the workshop. The following charts represent the “best fitting” OL principles based on a quantitative analysis of data. These principles were used to select the workshop’s scientist-educator teams and also to inform the “Focus Questions” for each scientist’s concept map.
Ocean Literacy Principle – “The ocean is connected to major lakes, watersheds and waterways because all major watersheds on Earth drain to the ocean. Rivers and streams transport nutrients, salts, sediments and pollutants from watersheds to estuaries and to the ocean.” (Damian)

Suggested Focus Questions:

- What are currently the most important water quality impacts on marine life (e.g., diel-cycling hypoxia, sources of pollution, nutrients, salts, sediments and pollutants)?

- How has human activity (especially in watershed regions inland of the ocean) impacted water quality and habitat function?
Ocean Literacy Principle - "The ocean dominates the earth's carbon cycle. Half the primary productivity on Earth takes place in the sunlit layers of the ocean and the ocean absorbs roughly half of all carbon dioxide added to the atmosphere." (wge)

Suggested Focus Questions:

- What affects the ocean’s current ability to absorb atmospheric carbon? (e.g., act as a “sink” for carbon)

- How are physical processes at the air-sea interface linked to climate change?
Ocean Literacy Principle - "Ocean biology provides many unique examples of life cycles, adaptations and important relationships among organisms (symbiosis, predator-prey dynamics and energy transfer) that do not occur on land." (Rhian)

**Suggested Focus Questions:**

- What unique reproductive strategies have organisms living in extreme environments developed to adapt to relative isolation in the deep-ocean (e.g., cold-water corals, hydrothermal vent invertebrates)?

- In what ways are cold-water corals similar to or different from their tropical shallow water cousins (e.g., responses to temperature, ocean acidification, pollution)? Do cold-water corals also provide a key physical structure for deep-sea communities?
Ocean Literacy Principle - "Humans affect the ocean in a variety of ways. Human development and activity leads to pollution and physical modifications. In addition, humans have removed most of the large vertebrates from the ocean." (Becky)

Suggested Focus Questions:

- What are the types and sources of riverine pollutants (agrochemicals/pesticides/dioxin) that anadramous fish are exposed to in Maine watersheds?

- How do these chemicals affect fish physiology, reproduction and behavior, and how does this in turn affect ecosystems in the watershed and in the ocean?
Ocean Literacy Principle - *"Over the last 40 years, use of ocean resources has increased significantly; therefore, the future sustainability of ocean resources depends on our understanding of those resources and their potential and limitations."* (Jeff)

**Suggested Focus Questions:**

- How can the connections between climate, ocean ecosystem productivity, and recruitment into the fisheries be explored through modeling?
- How are ocean-ecosystem models developed by scientists? How can these same models be used by resource managers and others to prepare for climate change effects on ocean resources?
USE OF “CURRENT SCIENTIFIC RESEARCH”

How often do you include current scientific research in your curriculum?

- Although I keep abreast of scientific research, there is not always time to share this with students. However, I have a "What's News in Science" bulletin board where I post some of the current research. This has to be adapted to the 6th grade level.
- Geared to high school students.
- Talk about science that is in the news.
- I teach Adult Ed students who are seeking their GED or High School Diploma. Beginning this year Diploma students can attend a 6 day 48 hour seminar that combines Science and Writing. I would like to include Ocean Literacy in this seminar and the regular academic year.
- It depends a bit on what curriculum unit we are covering....Newton's Laws of Motion, for example, does not lend itself quite as well to current research, although I am an avid Science News devotee.
- As often as possible, most Earth Science texts are out of date. - I use Nature, Scientific American, ACS, among others.
- It is a struggle to find paper resources that are accessible to students. Finding and providing them is extremely helpful for students to gain a better understanding of the process and life of science and scientists. Having scientists talk to students and explain research first hand can be an incredible experience for students, but it is always tricky to schedule.
- It is difficult to find current research that is written for 6th graders to understand. I use news articles more frequently than "research".
- I would like to improve this dramatically!
- I receive frequent info from Wood's Hole Oceanographic Institution and frequently research info on line.
- Weekly science news assignments as well as connecting new data to concepts covered in class.
- I would love to be able to introduce current research but covering the standards and the curriculum it is sometimes difficult to continuously introduce new materials.
How do you define "current scientific research"?

- Research that is happening now, is ongoing and builds on the past research that has occurred.
- Peer reviewed research in reputable publications, web databases, student generated data.
- Science that is being reported on now.
- Research that can be verified and duplicated. Unfortunately there is a lot of misinformation about the oceans and climate change, even though scientist are sharing the dire shape of the oceans their research is discovering. I think that the research on student learning is that the more involved the student is as a citizen scientist the more engage they are in their learning. And isn't that what we are trying to develop in our students?
- The latest in research
- Independent and group research occurring in universities and published in peer-reviewed journals, preferably!
- Endeavors of investigation being discussed among area specialists, usually online and not necessarily published yet.
- Primary papers from journals is what I think of first. I also use a number of media sources, including articles by science journalists and PBS-type programming that could be categorized as "current scientific research". Face time with scientists describing their research can also be in this category, but the results are usually still pending with this approach.
- Students read and report out on summary articles on current science research (daily science, science news for kids, etc...). We use this research to aid in Invention Convention. We also have an on-going invasive crab research project at Moose Point State Park (five consecutive years of data have been collected). Some of the 8th grade students at JFDS just got involved with the eel grass restoration efforts being done by Dr. Disney at MDIBL.
- I define current research as what is being investigated and reported on today. I also understand that this research might have begun long ago and will continue. This could be as simple as the incidence and severity of earthquakes in a calendar year or as complex as climate change research. I teach Earth System Science- there is always something in the news.
- Recent papers or current data that I can find online for my students to use.
- What I read from Wood's Hole and find on line.
- As current as possible. Many of the ideas such as Thermohaline Circulation are "old" but are continually being detailed.
- What is currently happening on research vessels, government, public and private institutions. State of the art technology.
How often have you interacted with *practicing scientists* in the past?

Please describe the types of interactions you have had with scientists:

- Using them as resources for and providing my background in methods of teaching science to assist my pre-service teachers in developing understanding of scientific concepts and current research.
- Listen to descriptions of their work. Worked with Dr. Jane Disney of MDI-BL on eelgrass restoration.
- I had regular interactions with scientists while obtaining my teaching certificate from a professor who was researching giant squid in 2004. and through additional coursework I have taken in oceanography in 2005. But have had intermittent interactions with scientists from the local water district regarding watersheds and hydrology.
- Helped write the Maine Ecobeaker program for state issued laptops, was a member of the ITEST for Maine laptops.
- 3 week long workshops on phytoplankton and remote sensing, nanotechnology and viruses and bacteria, field work
- Water quality monitoring, benthic fish counts.
- Aside from what is described above, I worked at the Jackson Laboratory doing adult stem cell research and differentiation for a semester through the MST program.
- Usually the interactions we have with scientists are after school. Although recently I took my grade 8 students to the University of Maine on a tour of different engineering departments. Students were about to talk directly with professors and graduate students.
- Most have been lecture style or observing a demo in their lab.
- UNH-students in the science club planted marsh grass at a local site. NOAA- I spent two weeks on Georges Bank counting marine mammals.
- The types? Usually during workshops/meeting or for direct
- Only through workshops and online articles...very limited