A National Oceanographic Partnership Program Award

A Proposal to Assess and Expand the COOL Classroom: A Web Site to Bring Real-time data from the Long-term Ecosystem Observatory (LEO) to 6-12 Grade Classrooms

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Long-term goals

A series of web-based, hands-on lesson plans were developed by an interdisciplinary team of scientists and K-12 educators (see www.coolclassroom.org) to capitalize on the cutting edge technology and real-time data streams available from the Coastal Ocean Observation Laboratory (COOL) and Long-term Ecosystem Observatory (LEO) operated by Rutgers University. The goal was to develop critical thinking and analytical skills among middle and high school students using the unique and compelling real-time data applications from COOL and LEO. The *COOL Classroom* is envisioned as an application of oceanographic research related to ocean observing systems for middle and high school students and teachers.

Objectives

This funded effort is designed to address three key educational needs identified by educators and scientists. These are: 1) development of Internet-based modules and distance learning programs that capitalize on an innovative research effort at the LEO underwater observatory, 2) implementation of a classroom pilot of the *COOL Classroom* web site in selected middle and high schools, and 3) enhancements to the *COOL Classroom* site based on a beta pilot.

Approach and Work plan

A consortium of middle and high school educators and ocean scientists was established to develop a series of web-based, hands-on lesson plans for dissemination to a broad K-12 audience that capitalize on the real-time data streams and current research activities conducted at the Long-term Ecosystem Observatory (LEO) operated by the Institute of Marine & Coastal Sciences. LEO is a state-of-the-art undersea laboratory located off the New Jersey coast and linked via an electro-optic cable to the Rutgers University Marine Field Station (RUMFS) in Tuckerton, NJ (Figure 1). The Coastal Ocean Observation Laboratory (COOL room) collects

real-time, oceanographic data using a variety of instruments such as satellites, coastal radars and underwater weather stations. Data is collected from the ocean floor and posted real-time on the Institute's web site (www.thecoolroom.org). A professional web firm (Blue Iceberg) was hired to create a web site for educational applications that was easy to navigate and had a professional look and feel.

Subsequently, Word Craft, a professional evaluation firm, was contracted to conduct a formative evaluation of the web product known as the *COOL Classroom*. Word Craft gathered information about the use and usability of the beta *COOL Classroom* website, activities and data by teachers to help improve the website and its offerings. Primary evaluation questions included:

- How are teachers using the *COOL Classroom* Website? Where are they going? What's most useful? What's least useful? What works well? What doesn't?

- Are the website materials presented in a format that teachers can use easily? If not, why and how can they be improved?

- Have the teachers used the real-time data? If no, why not? If yes, how were the data used?

- Are teachers using the website and/or the materials with their students? If yes, how, and how can both be improved?

- Are the website and materials useful? Are they supporting/enhancing what teachers do in the classroom or just complicating teaching? Are teachers likely to continue to use the website after this test period?

- What do teachers like most about the *COOL Classroom*? What do they like least?

A mix of Internet savvy and non-Internet savvy educators were selected for the project (Figure 2). Each educator was asked to participate in pre- and post-interviews and keep a journal during the program for evaluation purposes. IMCS education staff did not provide professional development for the participating teachers to simulate the real-world likelihood of a teacher happening upon the site, and consequently preparing and using the site in their classroom. IMCS-Rutgers plans to utilize results of the pilot evaluation to make improvements and enhancements to the COOL Classroom site.

Rutgers' Institute of Marine and Coastal Sciences (IMCS) is the focal point for New Jersey's education, research, and service efforts in coastal, estuarine, and open ocean environments. Established in 1989, the Institute is the leader in the study, development, and management of New Jersey's myriad marine-related environmental, economic, and educational assets. A nationally recognized scientific staff, state-of-the-art laboratories, and field stations situated at key locations combine to make Rutgers-IMCS a principal resource for those who manage, and raise awareness of, our valuable marine and coastal resources. The National Science Foundation (NSF) recently recognized IMCS as a Center for Oceanographic Science Education Excellence (COSEE). IMCS serves as the lead partner in the Mid Atlantic COSEE which capitalizes on the collective science and educational strengths of several institutions including the Center for Improved Engineering and Science Education (CIESE) at Stevens Institute of Technology, NY

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Aquarium, Hampton University, the University of Maryland Center for Environmental Science, Virginia Institute of Marine Science

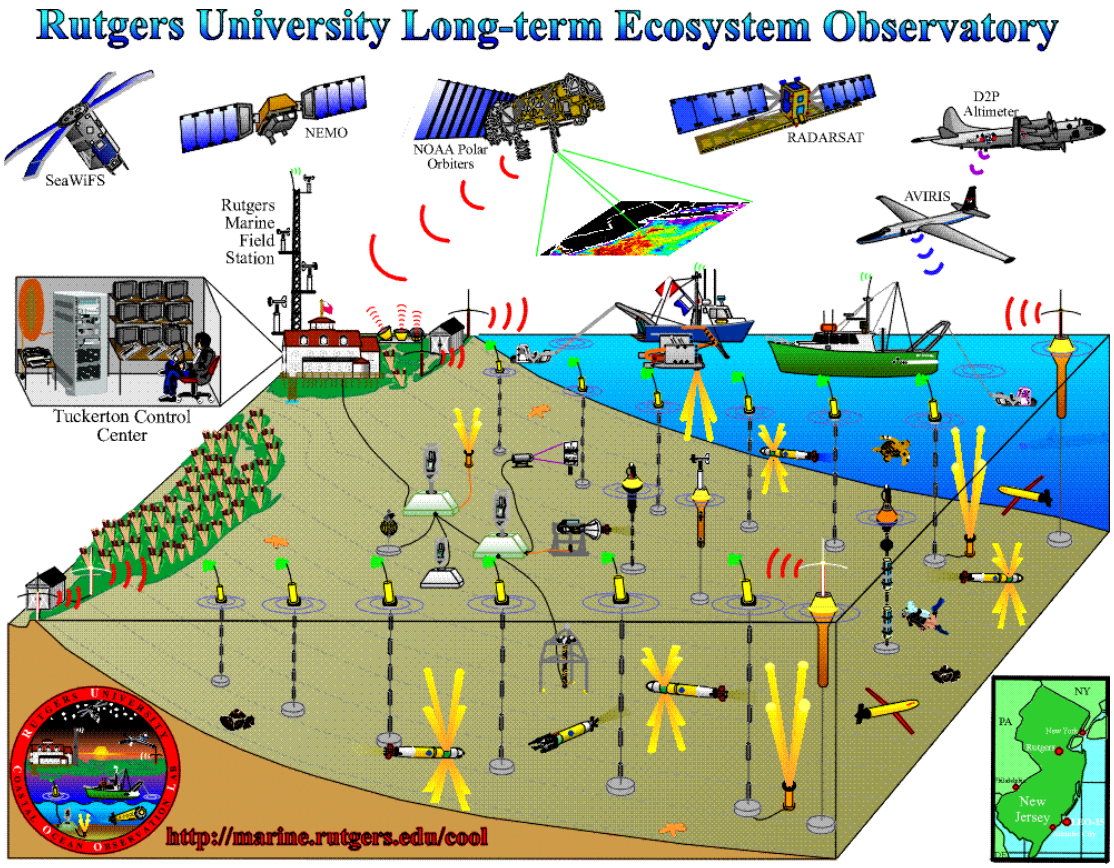

Figure 1: Cartoon of Long-term Ecosystem Observatory scientific array.

Figure 2: Students analyzing COOL Classroom data.

VIMS) of the College of William and Mary, two National Estuarine Research Reserves (NERR) located in New Jersey and Virginia, and the Chesapeake Bay Foundation (CBF).

Project leaders for the development of the COOL Classroom include **Janice McDonnell,** Education and Outreach Specialist at IMCS and Assistant Manager for the Jacques Cousteau National Estuarine Research Reserve. Ms. McDonnell is a nationally recognized educator with experience in developing and implementing education and technical training for a wide range of audiences including K-12 educators, students, coastal managers, and general public audiences. Janice facilitated the workgroup, coordinated curriculum contributors, conducted teacher training and coordinated distance learning programs. **Eric Simms** is an Education Coordinator for the Jacques Cousteau National Estuarine Research Reserve and Outreach Specialist for IMCS. Eric has been implementing MARE and other education programs in elementary and middle schools throughout the state. Eric supervised the graduate students and web page designer to refine and improve the LEO web pages. Eric facilitated the distance learning sessions.

Deborah Silver is an Associate Professor at the CAIP Center. Her current research includes visualization and quantification techniques to handle and enhance the understanding of time-varying 3D massive datasets and user-friendly interfaces to provide interactive access to scientific visualization. Dr. Silver advised a Graduate Assistant fellow (Vijay Balan) to assist in the visualization of LEO data. The GA worked specifically with the education staff and the workgroup to develop animated graphics and models of key LEO data to enhance understanding of key concepts.

Liesl Hotaling is an Internet Science Education Specialist at the Center for Improved Engineering and Science Education at Stevens Institute of Technology. She collaborated with practicing teachers to develop, field-test, and refine *COOL Classroom* materials, and created links to relevant state and national science, mathematics, and technology standards, as well as the assessment materials for classroom implementation. She served as the key liaison with IMCS and other NOPP partners to guide curriculum development efforts. A web firm **Blue Iceberg** (NY, NY) was hired to develop a web design that would engage both students and teachers.

Chris Parsons from WordCraft developed and implemented the evaluation program. Ms. Parsons has served as a consultant from Monterey Bay Aquarium, California State Parks, NERRS, and many others to design and implement K-12 and public education projects. Chris has consulted for Jacques Cousteau NERR on a number of important education projects.

Mike De Luca, Senior Associate Director, Institute of Marine & Coastal Sciences, Rutgers University. Mr. De Luca is the manager of the Jacques Cousteau National Estuarine Research Reserve and Director of the Mid-Atlantic Bight National Undersea Research Program. Mike oversaw all aspects of the project.

Work Completed

During this reporting period (1 October 2001 to 30 September 2002) the IMCS and its NOPP partners completed a beta web site of the *COOL Classroom* (Figure 3). Capitalizing on the interdisciplinary nature of marine science, a total of three modules were developed in the areas of Life, Physical, and Earth Science for grades 6-12. Each module consisted of a series of 4-6 individual lessons designed to progressively build upon one another. The first lesson in each module is an introductory lesson, designed to familiarize the student with the type of scientific equipment and data relevant to the

Figure 3: COOL Classroom homepage.

lesson. The next series of lessons are problem-based, using actual archived or "canned" data from the LEO observatory to reproduce a particularly interesting set of circumstances and reinforce the scientific concept behind the module. The final lesson(s) in the module focuses on data collection and involves students in the regular collection of real-time data over a period of time via the Internet. These lessons encourage students to make predictions based on prior knowledge and to draw conclusions from the data they collected.

Within each module, lessons are divided between middle and high school levels. For example, both sets of physical science lessons focus on the concept of vectors as measurements of speed and direction, and relate this concept to CODAR, a coastal radar system that measures ocean surface currents. However, while the middle school lessons ask students to apply their knowledge of vectors to predict the path of a floating bottle, the high school lessons directly apply the new knowledge of vectors to a phytoplankton bloom, as explained in the biological lesson using satellite imagery.

The life science lessons introduce students to the linkage between the physical concept of coastal upwelling and the resultant biological phenomena of a phytoplankton bloom. Using sea surface temperature images from satellite sensors, students are asked to predict where an upwelling, and in turn a phytoplankton bloom, would be expected to occur. Students can even take it a step further to explore a marine food web through the connection between a phytoplankton bloom and where fish can be found.

The earth science lessons explore a variety of oceanographic events. Several examples are using satellite images to study the Gulf Stream and ocean temperatures, learning how underwater sensors provide water column profiles, using meteorological data to examine the relationship between the ocean and atmosphere, and combining all this information to predict ocean conditions for swimming and fishing.

Each of the lessons in a module is further complemented by a variety of instructional tools. These tools include static graphs, pictures, and images, video clips, interactive tutorials, and 3-D animations that introduce or reinforce concepts contained in the individual lessons.

Teacher's Guide

Education resources at the JCNERR help to prepare the educator as the principal facilitator of knowledge in the classroom, providing them with best practices in curriculum delivery and assessment. The *COOL Classroom* exemplifies this commitment through the Teachers Guide (formerly Teachers Lounge) section of the web site. Within this area, educators can find background information on LEO and it's associated technology, downloadable forms for classroom use, suggestions for model lesson plans and interdisciplinary learning, and descriptions of modules and their associated national and state standards. IMCS and JC NERR staff also provided professional development opportunities for the *COOL Classroom* curriculum on site in southern New Jersey, and through distance learning technology.

IMCS staff realizes the value and necessity of assessing student performance. Each module in the *COOL Classroom* includes summative assessment tools to evaluate student comprehension of the lesson concept. In addition, the modules are journal-based, allowing students to exercise writing and analytical skills as they progress through the lessons.

A complete formative evaluation of the COOL Classroom website was conducted by Chris Parsons of WordCraft. To gather the data needed, Ms. Parsons interviewed seven middle-school teachers after they had visited and reviewed the website and used it with their students between April and June 2002. Due to travel constraints, we conducted face-to-face interviews with four of these teachers and telephone interviews with the remaining three teachers. The interviews consisted of a discussion about the use of the website by the teacher and her/his students, then "clicking through" each of the features of the website online to determine which features were used and what the teacher liked/disliked about each.

Results

Results of the *COOL Classroom* evaluation were extremely insightful in explaining the use of web-based resources by teachers and students in the classroom. Due to diverse student ability, teacher knowledge of science and teaching competencies, we received a wide range of responses on the use of the website. Generally, the middle-school teachers (who were more familiar with science content and teaching more advanced students) were able to adapt and use the website as designed. However, only 2 of the 7 evaluated were middle school teachers.

For the majority of the teachers evaluated, use of the science content and real-time data on the web site were beyond their skills. They weren't sure what to do with it (and if they don't understand it, they're unlikely to use it with their students). Presentation of lessons by traditional techniques (simple to complex) contributed to the loss of teachers and student interest by Lesson

3. To compensate, teachers looked for the fun (food web game) and familiar (facts, cards and terms).

Professional development sections of the website such as "About This Site" and "Teacher Lounge" were generally ignored by the teachers. These educators didn't view these areas as sources of information on site utility or lesson use. This may have been due in part to lack of time, interest and diligence, but also to being overwhelmed by too much content.

Teachers liked the overall look of the website. The main complaint concerned appearance of the text—it's small size and the amount on scrolling pages. Teachers asked for more direction and more "chunking" of information (possibly with discrete pages rather than scrolled information).

Generally, middle-school teachers with no *COOL Classroom* website training found the main point of the website (using real-time data) too advanced for them. They needed help getting the main point of the site and understanding the content. Although they said they found the site appealing and that they would continue to use it, this is unlikely if the website remains in its current format.

Recommendations

Based on teacher feedback, IMCS education staff identified two options to improve understanding and use of real-time data in the classroom: (1) offer teacher training on the use of the website, and/or (2) post a tutorial on the website on how to use the features with students. The tutorial may be accomplished through a webquest or worksheet designed for students to guide them through information collection from one or more sites. Given the results, the evaluator made the following recommendations to make the site useful to a wider range of middle-school teachers:

1. Create a webquest for teachers to explore the site for orientation, and the most important features of the web site. Post the teacher webquest on the website with a home page button or other directive that teachers should start there first.
2. Create a webquest for students to explore the site for orientation. This should be the first lesson in the series of lessons for students. As with teachers, students should visit the most important features.
2. Change the presentation of the three lessons (under C.O.O.L. projects) so that students are challenged by one or more projects. Then, guide students through the project(s), providing background information as needed when needed so that students can complete their projects.
3. Offer students the option of doing the project from different perspectives/roles. For example, a student could be a writer preparing an article for anglers, or a boat captain directing crew to the fishing spot, or a researcher aiming to tag fish. Each student would work through the same lessons (collect and interpret the same data) but from a different perspective. The final product would look/sound different depending on the role played. Lessons also should be presented as a discrete page. Chunk the information; teachers and students were overwhelmed/discouraged by having to scroll through the pages.

4. Pull the C.O.O.L. Cards and C.O.O.L. Facts into the lessons. Although teachers and students like these, they didn't really see how they related to the lessons. The C.O.O.L. Cards could be part of the role playing in webquest.

5. Add a directory to the Teacher's Lounge so that teachers know what's there.

Restructure the Teacher's Lounge to include everything that's not for students (i.e., combine the Teacher's Lounge and About this Site).

Based on these recommendations, IMCS education staff (McDonnell and Simms) made the following changes to the COOL Classroom site:

1. Added an Introduction to the COOL Classroom worksheet to direct students and teachers to relevant background information. A button was added "teachers click here: learn how to use this site". The information in the Teachers Lounge (renamed Teachers Guide for clarity) was divided and indexed for easier viewing and downloading.
2. The Earth Science and Physics lesson (Biology in revision) were revised and reordered in a modified webquest format. The real-time data lesson was placed first in the lesson series and the canned data lesson and background information was reordered to support this central lesson. The linear format of introduction, practice, and real-time data lesson was abandoned for this more integrated approach.
3. COOL cards and the Control room tutorials were more heavily integrated into the student lessons using the modified webquest format

A regional evaluation is planned in Spring 2003 (utilizing a renewal grant from NOPP) to test these revisions. An asynchronous, professional development course that can be taken on-line using web-based learning modules that uses discussion boards, real-time chat, Whiteboard, and content management, including video, pictures, and text also will be developed. Overall, the renewal effort will focus on broadening and improving access to data from LEO-15 through a national pilot program and new Internet module for target audiences including K-12 educators and students, families, home school parents and students, environmental organizations, and other key audiences such as coastal decision-makers.

Impact and Applications

To many Americans, the coastal ocean is among our Nation's most important natural resources. Nowhere is this more important than the Mid-Atlantic region. Competing uses result in complex environmental consequences of human and natural disturbance such as nutrient over-enrichment, chemical pollution, sand mining, beach erosion, toxic algal blooms, and declining fisheries. The public, media, and decision-makers debate these issues constantly. It is a challenge to translate research into findings meaningful to the public and environmental managers, and to engage, educate and develop an informed citizenry that understands the nature of scientific inquiry.

A recent public opinion survey found that many Americans have misleading ideas about the ocean and coastal environment. For example, four out of five Americans do not identify pollution running off the land as a problem for the oceans, although it is the leading source of marine pollution (NOAA, 1999). Over the past decade, the reform of science education has called for the development of innovative pedagogy and the integration of science and education

research. As a result, there is a tremendous need for scientists and educators to work together to improve public knowledge and understanding of how the ocean affects their daily lives. The *COOL Classroom* represents one initiative aimed at fostering such integration.

Economic Development

In the long-term, the COOL Classroom aims to increase student-teacher understanding of the oceans using real-time data from the nation's emerging network of coastal ocean observatories. Our goal is to use this scientific capability to increase understanding of the processes that govern change and stability in the coastal environment, and that this understanding will lead to heightened awareness and stewardship of the marine environment.

Data from the COOL room also has the potential to provide information services that can help save lives, save money, and solve problems related to coastal resources, habitats, and processes. These include environmental and economic decisions associated with shoreline management, energy, health, tourism, construction and recreation. Armed with awareness, access to timely information, and with the skills needed to translate data into informed decisions, our students can be equipped to be the next generation of informed citizens and stewards.

Quality of Life

COOL Classroom and the COOL room are designed to promote awareness and understanding of ocean sciences by integrating research and education programs and resources to encourage lifelong learning experiences for K-12 teachers, students (K-16), recreational fishers, swimmers, and boaters. Lifelong learning and environmental stewardship is supported with real-time data available from coastal ocean observing systems.

Science Education and Communication

Through the *COOL Classroom*, NOPP partners capitalized on natural student fascination with the ocean and access to advanced technology and data from ocean observing systems to create educational resources that promote basic scientific skills and understanding, problem solving and analytical thinking, and environmental awareness in the classroom. Technology-based learning materials, such as those developed through this NOPP project, have been used successfully at local and national scales. This approach exemplifies the statement that technology "makes it possible to create learning situations that mirror what is happening in the real world in ways that are difficult to realize in a traditional classroom" (Vosniadou, 1994). We are further encouraged about the success of this approach by reports from the National Science Teachers Association that 4th and 8th grade students who used computers for learning activities had higher assessment scores (NSTA, 2001).

<u>Transitions</u>

Quality of Life

Nationally, the *COOL Classroom* model is being evaluated by the 26-site, National Estuarine Research Reserve System for potential applications to the coastal management community. In New Jersey, the Jacques Cousteau NERR is considering using the *COOL Classroom* format to develop courses and materials for coastal decision-makers (defined as those who during the course of their professional lives make decisions that effect the coastal zone).

Science Education and Communication

Members of organizations such as the National Science Teachers Association (NSTA), the National Marine Education Association (NMEA), and the Centers for Ocean Science Education Excellence (COSEE) are currently reviewing the *COOL Classroom* website to determine its merit and utility in national science education initiatives.

Related projects

The COOL room (www.thecoolroom.org) developed in conjunction with N00014-02-1-0917.

References

National Science Teachers Association (NSTA) Legislative Report. November 2001. Online at http://nces.ed.gov/nationsreportcard.

Vosniadou, S. 1994. From cognitive theory to educational theory. In S. Vosniadou, E. De Corte, & H. Mandl, (Eds.) Technology-based learning environments: Psychological and educational foundations. Berlin: Springer-Verlag. pp.12-18.

Publications

Simms, Eric., J. McDonnell, and M. De Luca. 2002. Using an Ocean Ecosystem Observatory and the Internet to Bring Meaningful Science Education and Real-time data into the Middle and High School Classroom. Current: the Journal of Marine Education. Vol 18 No.2 p.32-37.