

***Communicating Ocean Sciences:  
A Course That Improves Education & Public Outreach***

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**ABSTRACT:** Among all disciplines of science and geoscience, ocean/marine/aquatic sciences are inexplicably and idiosyncratically underrepresented in K-16 education. Concepts and topics about the ocean are hardly taught in K-12 schools, and hardly appear in K-12 curriculum materials, textbooks, assessments or standards. The NSF-funded Center for Ocean Sciences Education Excellence—California (COSEE CA) has brought together educators at the Lawrence Hall of Science, UC Berkeley with faculty at UCB to address this issue. Together educators and ocean scientists have developed and teach a university course entitled *Communicating Ocean Sciences* that is now being taught in several institutions of higher education nationwide. The course is designed for undergraduate and graduate science students interested in improving their teaching skills, or simply interested in improving their ability to communicate about complex science concepts. The goals of the course are to: 1) introduce diverse future scientists to the importance of K-12 education, public outreach and the “broader impact” of their research in ocean sciences; 2) introduce diverse students in science majors to possible careers in K-12 teaching; 3) encourage thoughtful, mutually beneficial collaborations between ocean scientists and educators co-teaching the course; 4) provide significant ocean sciences instruction and college-age role models for under-represented K-12 students. The course involves university students in a semester of seminars and six weeks of teaching Ocean Sciences to elementary and middle school students under the supervision of experienced classroom teachers. To date, approximately 100 students have taken this course at the University of California, Berkeley and three other campuses. By academic year 2005-06, we expect that a dozen colleges and universities will be offering the course.

This paper focuses on the content, outcomes, and potential of the *Communicating Ocean Sciences* course. First, we describe the background and design of the course. Next, we explore the implementation of the course at the University of California, Berkeley and describe participant, instructor, and institutional experiences of the course. Finally, we discuss the potential of the course to transform teaching and learning of Ocean Sciences across the United States.

Background

Course Design

This innovative course introduces undergraduates and graduate students in ocean sciences and related majors to inquiry-based instructional strategies for communicating their

passion for their subject area. These strategies, combined with the students’ content knowledge and enthusiasm for sharing it, equip them to introduce ocean sciences to K-8 students and teachers in local schools. The Goals of the course are: to introduce diverse future scientists to the importance of K-12 education, public outreach and the “broader impact” of their research in ocean sciences; to introduce diverse students in science degree programs to possible careers in K-12 teaching; to encourage thoughtful, mutually beneficial collaborations between scientists and educators co-teaching the course; to provide significant ocean science instruction and college-age role models for underserved and underrepresented K-12 students.

*Communicating Ocean Sciences* provides college students, faculty and K-12 teachers experience with exemplary instructional materials that illuminate best practices in science teaching through nine, 2.5-hour long, inquiry-based sessions. The students are immersed in several weeks of hands-on ocean sciences activities designed to illustrate key elements of K-12 pedagogy and science content. Then pairs of students select an ocean sciences unit (and kit) to teach in a local K-8 classroom where they spend the next six weeks (1-2 hours/week), working side-by-side with a classroom teacher, exploring inquiry-based ocean sciences content with children. The last few sessions are spent discussing and reflecting on their experiences, and applying them to their future careers.

Some of these undergraduate and graduate students will be enticed to careers in education (we estimate approximately 10%); many are likely to become scientists that are thoughtful about their own teaching, and knowledgeable about education issues and sympathetic to the need to provide outreach. This course provides the mechanism to spawn a generation of scientists actively involved in educational outreach from the outset of their careers. Pre-existing elements of the *Communicating Ocean Sciences* course have been effectively used in preservice and inservice settings to demonstrate key pedagogical principles to potential and experienced classroom teachers.

*Course Implementation—the Story...*

Teaching the Course at UC Berkeley

The course was taught for the second time in the 2005 Spring semester at the University of California, Berkeley. The enrollment in the course this spring was double that of the pilot test in spring of 2004. This year 32 undergraduate and

graduate students from the departments of Integrative Biology and Earth & Planetary Sciences with training or interest in ocean sciences completed the *Communicating Ocean Science* course.

A few changes were implemented in the course based on our experience with the pilot test in spring 2004. Originally, the course met two hours per week and was offered for 2 units. We petitioned to change the course to three units based on increasing the lecture/seminar time to 2.5 hours per week and our inclusion of a required course reader and online discussion prompts. The course reader was compiled to accompany the class sessions and provide more background and access to seminal papers on the educational strategies and pedagogy presented in the course. The online discussion prompts, which preceded each class session, provided opportunities for the students to reflect on their learning and formulate points of view. This simple modification to the course greatly enriched and enlivened class discussions. It also provided us with a wealth of information and insight about how our students experienced their own K-12 careers, how they are now experiencing being science students at UC Berkeley, and how that affects them as “teachers” of K-12 students. Students accessed the online discussion prompts through the student portal of the course website at [www.cacosee.net/collegcourse](http://www.cacosee.net/collegcourse). We plan to summarize the data from the online discussion prompts and are discussing how best to disseminate the results.

Other changes in the course included receiving approval to add graduate course numbers in addition to the upper division credits available. The course is now listed at UC Berkeley as a cross-listed undergraduate course in Integrative Biology (Ibc100) and Earth and Planetary Science (EPSc100) as well as a cross-listed graduate course (IB c215 and EPS c301). EPS has also approved the Communicating Ocean Sciences course as one which graduate students may take to fulfill a requirement to complete a course on teaching before becoming a GSI. Starting in fall 2005, the course will also be added to the EPS Marine Science major strand.

#### Field Test Sites

Three institutions in addition to UC Berkeley offered the course in academic year 2004-2005. The University of Oregon's, Oregon Institute of Marine Biology offered the course as part of their NSF GK-12 program. (See letter of support for the Educational Initiatives Award attached.) The course was also offered at the University of California, Santa Barbara (UCSB) and Oxnard Community College. The first two institutions attended our first Field Test Workshop held in June of 2004 where they received information and materials to implement the course at their site. The third institution, Oxnard, met separately with us to receive the orientation to the course and the materials for implementation. We heard very positive results from all three replications—including how popular the course was with the graduate students at UCSB. (See initial evaluation comments below.)

All participants of the 2004 Field Test workshop were sent surveys regarding their implementation of the project. Many of the participants of the Summer 2004 Field Test workshop that have not yet implemented the entire course, have nonetheless used aspects of the course and/or educational outreach in other existing courses or efforts. They have found the COS instructor's manual and the LHS MARE and GEMS curriculum materials used in the course to be effective and easy to use in an array of settings.

As in Year 2, we spent considerable effort recruiting science faculty and science educators to sponsor and co-teach the course in Year 4 at additional institutions. Our recruitment efforts centered on the National COSEE Network, National Marine Educators Association, contacts through our COSEE CA Advisory Committee, notices in the Consortium for Oceanographic Research and Education electronic newsletters, poster and paper presentations at national oceanographic conferences including AGU and ASLO and our own personal/professional networks. On June 6-8, 2005 we held the second Communicating Ocean Sciences Field Test Workshop. The workshop was for teams of scientists and educators that intend to teach the course in academic year 2005-06. We are pleased that teams or individuals from 11 different universities/institutions were represented at the workshop:

San Francisco State University  
Sonoma State University  
Rutgers University  
Mote Marine Laboratory  
Stanford University  
Duke Marine Laboratory, Duke University  
Woods Hole Oceanographic Institution  
Oregon State University, Hatfield Marine Laboratory  
University of Washington  
Oxnard Community College  
North Carolina State University

We have heard from additional institutions interested in teaching the course but were not able to send a team to the June workshop. We will meet with them individually to introduce them to the course materials and to discuss adapting the course for their circumstances.

In order for these institutions to be considered a field test/dissemination site, applicants will need to meet the following criteria:

- an ocean scientist must sponsor and co-teach the course
- an informal educator, master teacher or education faculty must co-teach the course
- the institutions must have undergraduates and/or graduate students in ocean sciences-related majors
- the institution must have or desire to have relationships with local schools and a commitment to provide outreach to local schools

	<b>Always</b>	<b>Most of the Time</b>	<b>Some of the Time</b>	<b>Rarely</b>	<b>Never</b>	<b>I'm Not Sure</b>
The instructors were very knowledgeable about ocean science.	75%	25%	0%	0%	0%	0%
The instructors were very knowledgeable about teaching.	98%	3%	0%	0%	0%	0%
The instructors were well prepared for class.	90%	10%	0%	0%	0%	0%
The instructors were easy to approach (e.g. I knew I could speak to them if I had a question or concern).	93%	5%	3%	0%	0%	0%
The instructors provided me with the support I needed to succeed in the course.	87%	13%	0%	0%	0%	0%
The instructors provided me with the support I needed to succeed in teaching elementary school students.	95%	3%	3%	0%	0%	0%

*Course Implementation—The Analysis*

Evaluation efforts to learn about the effectiveness of the course at UC Berkeley and the implementation of the course at participating institutions of higher education (IHE) are currently underway. To date, data collection efforts have included surveys of: participating students at UC Berkeley at the beginning of the course during both Spring 2004 and 2005, host K-12 classroom teachers at the end of both the Spring 2004 and 2005 semester, participants in the Summer 2004 and 2005 Trial Test Workshops, and facilitators of the course at other IHEs. In addition, selected interviews were conducted with course organizers and instructors at UC Berkeley and other IHEs. Accordingly, the analysis presented in this paper draws from several data sources: interviews with course developers and instructors, course observations, surveys of participating students and supervising K-12 teachers, interviews and surveys of course instructors at other institutions of higher learning.

*Successes and Challenges*

Preliminary analysis of data regarding the UC Berkeley course indicates the success of the course. At the end of the course students were asked a series of questions designed to assess the effectiveness of the course. The following table indicates a selection of those results:

These survey data, across both semesters of implementation, indicate the following preliminary conclusions:

- students were generally satisfied with the content of the courses most students felt that they received adequate support working with the classroom teacher and course partner.
- students overwhelmingly felt that the course had influenced the way they think about learning and teaching.
- almost two-thirds of the students felt that the course had influenced their plans for the future.

In addition, student participant surveys across both years of implementation suggest that UC Berkeley Instructors were excellent.

Finally, survey data also indicate that students found all aspects of the Communicating Ocean Sciences Course to be a positive experience. When asked to rate aspects of the course as negative (0), just O.K. (1), somewhat positive (2), and positive (3), students rated the following items exceptionally high with the average overall rating of 2.7:

<u>Item</u>	<u>Mean</u>
Participating in the class	2.7
Being in the elementary school classroom.	2.9
Teaching in the elementary school classroom.	2.9
Working with my partner.	2.7
Working with the classroom teacher in whose classroom I was placed.	2.6
Doing the assignments I received in the class.	2.3
Using the MARE and GEMS curricular materials.	2.6

	<b>Strongly Agree</b>	<b>Agree</b>	<b>Neither Agree nor Disagree</b>	<b>Disagree</b>	<b>Strongly Disagree</b>	<b>Not Sure/Not Applicable</b>
I think that the Communicating Ocean Science course should have included more ocean science content.	8%	25%	40%	18%	8%	3%
I needed more support working with the classroom teacher to whom I was assigned.	8%	13%	10%	21%	44%	5%
I needed more support with working with my partner.	8%	13%	8%	10%	58%	5%
My experience in the Communicating Ocean Science Course has influenced the way I think about learning.	75%	20%	5%	0%	0%	0%
My experience in the Communicating Ocean Science Course has influenced the way I think about teaching.	85%	15%	0%	0%	0%	0%
My experience in the Communicating Ocean Science Course has influenced my plans for my future.	43%	23%	25%	0%	5%	5%

When asked “Are there any other aspects of the course that you found particularly positive?” one student noted “The class was one of the best classes I’ve taken at Berkeley. The instructors were amazing and enthusiastic...very great to work with. They made the teaching experience fun and easy. They were very accessible and provided all the necessary materials.” Another student made a similar comment writing that the course was “the best course I’ve ever taken in my college career.”

Others indicated how positive the elementary school experience was for them. Comments included:

*“The greatest experience the course offered is interacting with elementary school students and being on the other side of the picture (rather than being the student we become the teacher).”*

*“I wish we could have started working in the classrooms earlier so that we didn’t have to cram all the sessions at the end.”*

When asked, “are there any other aspects of the course that you found particularly negative?” most comments focused on logistics such as: time of course, length and infrequency of course sessions, and the difficulty with transportation to and from the elementary school classrooms.

Survey data collected from the elementary school classroom teachers who hosted the *Communicating Ocean Sciences* students in their classrooms also underscored the success of this course. Teachers indicated that the presence of course participants in their classrooms was a positive one for them and their students. All respondents to our teacher survey indicated that their students both learned about ocean sciences and had a positive experience as a result of the involvement of the *COS* students. One teacher noted that the *COS* students who came to her classroom were “just great! Very efficient, focused, prepared, open to feedback, and enthusiastic. My students really liked them and their lessons. Thank you!” Several of the teachers echoed these sentiments. Teachers also felt that the presence of these students was supportive of their work as teachers. One teacher noted that “One of the most difficult tasks of teaching science is gathering all the materials. It was so nice to have a program that was so student interactive, and I didn’t have to do the gathering.”

Classroom teachers who hosted *COS* students also offered some suggestions for improving that aspect of the course. One teacher mentioned that it would be helpful to have an outline of the six-week program so that they could support the program further in their classrooms even when the *COS* students were not there. Other teachers offered logistical suggestions focused on making the activities run more smoothly.

### *Student Outcomes*

Preliminary analyses of these data suggest several important findings. First, the course provides participants with an experience that helps shape their understanding of the Ocean Sciences. Second, the course facilitates participants’ learning of powerful pedagogy for teaching Ocean Sciences. Third, the course helps shape students career aspirations.

### Learning about Ocean Sciences

Several students commented that preparing to teach science to young children caused them to deepen their own understanding of difficult science concepts. Attempting to explain complex ideas to elementary aged students often helped to uncover profound misconceptions held by the university students. Though the intention of the course is not to teach students extensive content knowledge about the ocean, we are certain that student understanding of ocean sciences content does improve.

### Learning to Teach about Ocean Sciences

As reported above, survey results indicated that students overwhelmingly felt that the course had influenced the way they think about learning and teaching.

In addition, pre/post comparisons of survey results indicate participants increased sense of comfort and preparedness for teaching about Ocean Sciences. Students were asked to rate the degree to which they agree with the following statements at the beginning and end of the course:

- I feel very comfortable leading a discussion
- I feel well prepared to teach elementary school students about Ocean Sciences
- I enjoy teaching science to elementary school students
- Prior to the course a significant percentage of participants indicated that they were not sure or disagreed with these statements. By the end of the course most students (over 80%) agreed with all three of these statements.

Pre post comparisons of survey results also evidenced students’ increased familiarity and practice with pedagogical approaches for teaching Ocean Sciences. Students were asked to indicate their level of familiarity with the following concepts: constructivist learning theory, “hands-on” approaches to teaching and learning, classroom management, and misconception theory. Students claimed gains in all areas.

### Shaping Career Aspirations

Almost two-thirds of the students felt that the course had influenced their plans for the future. Approximately 10% of the students surveyed said that they had actually decided to pursue a teaching credential and a career in K-12 education.

*Institutional Outcomes Transformative potential (inclusion of other institutions)*

The course has the potential to transform Ocean Sciences education through implementation in Institutions of Higher Education across the United States. Preliminary data indicate that many of the institutions are using the course in innovative ways including as part of other science and/or preservice courses with very positive results.

The potential of the course to support institutional transformation is also evidenced in the student survey results.

In 2004 only 7% of the students indicate that they took the course because someone who took a communicating science course recommended it; by 2005, 27% of participants identified this as a reason for taking the course.

In 2004 20% of the students indicated that they took the course because their advisor recommended it; by 2005 30% of students identified this as a reason for taking the course.

In 2005 54% of the enrollees identified the fact that the course fulfilled a departmental course requirement as a reason for their decision to take the course.

Future evaluation activities will focus significant attention on learning about the implementation of the course at other IHEs. Data collection plans include: conducting additional interviews of involved personnel at participating IHEs, surveying the other seven institutions that attended the first Trial Test Workshop (June 2004) and those that attend the June 2005 workshop, and surveying students who participate in the course at these institutions.

Conference Presentations

We presented a poster at AGU in December 2004 and a paper at ASLO in February 2005. Presentations on the *Communicating Ocean Sciences* course have also been given at the National Marine Educator's Association Conference in July 2005 and will be given at the California Science Teacher's Association Conference in October 2005. A paper *Communicating Ocean Sciences: A Course That Improves Education & Public Outreach* was submitted to the Oceans 2005 MTS Conference in Wash. D.C. for September 2005.

Educational Award Recipient

We are very proud to announce that *Communicating Ocean Sciences* and its sister course, *Communicating Science* received the prestigious 2005 Educational Initiatives Award from the University of California, Berkeley. The Educational Initiatives Award is an award presented annually to a department or unit on the Berkeley campus in recognition of distinctive contributions to undergraduate education. Designed to complement the campus's Distinguished Teaching Award for individual faculty, the Educational Initiatives Award is presented to a department, unit, or group of faculty that has created an outstanding program or initiative that has had a

sustained impact upon undergraduate education and can serve as a workable model for others on campus.

Conclusion

We are continuing to search for new opportunities to disseminate the *Communicating Ocean Sciences* course including submitting proposals for further funding. Other COSEE Centers including COSEE Southeast, COSEE Florida and COSEE Mid-Atlantic intend to include the *Communicating Ocean Sciences* course as an integral part of their COSEE efforts.