9-22-2010

COLLABORATIVE RESEARCH: Centers for Ocean Science Education Excellence- Ocean in the Earth-Sun System

Lee Karp-Boss
Principal Investigator; University of Maine, Orono, lee.karp-boss@maine.edu

Emmanuel S. Boss
Co-Principal Investigator; University of Maine, Orono, emmanuel.boss@maine.edu

Final Report for Period: 09/2009 - 08/2010 **Submitted on:** 09/22/2010

Principal Investigator: Karp-Boss, Lee . **Award ID:** 0528702

Organization: University of Maine

Submitted By:

Karp-Boss, Lee - Principal Investigator

Title:

COLLABORATIVE RESEARCH: Centers for Ocean Science Education Excellence- Ocean in the Earth-Sun system

Project Participants

Senior Personnel

Name: Karp-Boss, Lee

Worked for more than 160 Hours: Yes

Contribution to Project:

COSEE-OS Co-Principal Investigator, Assistant Research Professor of Marine Sciences, School of Marine Sciences, University of Maine, developer and instructor for 'Teaching Physical Sciences by Ocean Inquiry' semester course and 'Teaching Sciences by Ocean Inquiry' workshop, scientific review of educator resources (2006, 2007, 2008)

Name: Boss, Emmanuel

Worked for more than 160 Hours: Yes

Contribution to Project:

COSEE-OS Co-Principal Investigator, Associate Professor of Oceanography, School of Marine Sciences, University of Maine, Summer developer and instructor for 'Teaching Physical Sciences by Ocean Inquiry' semester course and 'Teaching Sciences by Ocean Inquiry' workshop, scientific review of educator resources (2006, 2007, 2008). Co-author on a special issue 'Teaching science by ocean inquiry': a collection of hands-on/minds on inquiry based activities for teaching physical concepts in the context of ocean processes (to be published in Oceanography).

Name: Karp-Boss, Lee

Worked for more than 160 Hours: Yes

Contribution to Project:

COSEE-OS Co-Principal Investigator (and PI since Sep. 2008) , Assistant Research Professor of Marine Sciences, School of Marine Sciences, University of Maine, developer and instructor for 'Teaching Physical Sciences by Ocean Inquiry' semester course and 'Teaching Sciences by Ocean Inquiry' workshop, scientific review of educator resources (2006, 2007, 2008)). Lead author on a special issue 'Teaching science by ocean inquiry': a collection of hands-on/minds on inquiry based activities for teaching physical concepts in the context of ocean processes (to be published in Oceanography).

Post-doc

Graduate Student

Name: Albright, Jennifer

Worked for more than 160 Hours: Yes

Contribution to Project:

M.Ed. candidate in Secondary Science education, University of maine, Graduate Teaching Assistant for 'Teaching Sciences by Ocean Inquiry' semester course and workshops (2006, 2007, 2008). Co-author on a special issue 'Teaching science by ocean inquiry': a collection of hands-on/minds on inquiry based activities

for teaching physical concepts in the context of ocean processes (to be published in Oceanography).

Undergraduate Student

Technician, Programmer

Name: Loftin, James

Worked for more than 160 Hours: Yes

Contribution to Project:

Technician, school of Marine sciences, university of Maine.
Assisted with the design and preparation of laboratory activities (for the semester course and summer workshops). Constructed new equipment for laboratories activities. Co-author on a special issue 'Teaching science by ocean inquiry': a collection of hands-on/minds on inquiry based activities for teaching physical concepts in the context of ocean processes (to be published in Oceanography).

Other Participant

Name: Smith, Lori

Worked for more than 160 Hours: Yes

Contribution to Project:

Research Associate, Center for Research and Evaluation,
University of Maine, Center overall evaluation (2007, 2008)

Name: Weller, Herman

Worked for more than 160 Hours: Yes

Contribution to Project:

Dr. Weller was the PI on this project until his retirement in Fall 2008.
He was the science education person on this project and participated in designing and teaching a new college level course (Teaching Sciences by Ocean Inquiry) and workshops for middle-school and high-school teachers.

Research Experience for Undergraduates

Organizational Partners

Bigelow Laboratory for Ocean Sciences

Bigelow Laboratory for Ocean Sciences - is focusing their efforts on editorial review of 'Oceans in the News' articles and scientific review of concept-based educational resources

Maine Mathematics and Science Alliance

Maine Mathematics and Science Alliance ? continues to advise 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.

University of New Hampshire

University of New Hampshire (UNH) ? has 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 'Climate and Oceans - Using Ocean Based Data' at UNH

Other Collaborators or Contacts

Activities and Findings

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

Research and Education Activities:

During the course on of the project we designed and presented high-quality and science-based educational experiences that emphasize fundamental science concepts within an ocean context to ensure broader applicability (e.g., beyond the coasts). We adapted tools and resources that help to engage students in learning and developed a collection of hand-on/mind-on activities for teaching physical concepts in Oceanography, that can be used with a broad range of audience in both formal (middle school to college-level students) and informal (science museums, aquariums) settings.

Our team (Weller, Karp-Boss and Boss) efforts focused on three avenues for disseminating educational experiences and products:

(1) Summer workshops for in-service teachers ('Teaching Sciences by Ocean Inquiry'): During the summers of 2006-2008 we conducted a total of four, one-week long workshops for high-school and middle-school teachers who teach physics and physical sciences. Goals were to: a) 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 b) develop a network between teachers, scientists and experts in education. Teachers worked closely with program instructors to augment content-based knowledge in oceanography, develop teaching materials and means of assessments, and participated in pedagogy discussions on inquiry-based teaching and learning. A total of 58 teachers, from 16 different states participated in these workshops (ME (30), NY(6), NC(4), MA(2), NH (2), OH (2), SC(2), TN(2), AZ(1), FL(1), ID(1), KY(1), MO(1), NM(1), PA(1), VA(1)). About three quarters of the participants were from inland communities.

(2) A new, intedisciplinary, college level course for pre-service teachers and marine science majors. This course provided a unique opportunity for marine science students who are interested in incorporating an educational aspect to their science backgrounds. Whether they intend to be classroom teachers, research scientists, or informal educators, these students elected to make an investment in their future by learning strategies to effectively communicate ocean science. The course addressed several goals: 1) Introduce pre-service teachers to concepts in marine sciences, using inquiry based learning and teaching approaches, 2) help young marine scientists to more effectively communicate their subject and 3) create a greater awareness among scientists about the need for outreach. In several cases these students had initiated their own exploration in education by seeking out opportunities to teach science to young people and/or the public. With a more structured and formal approach, this course helped them to refine and reflect on their educational interests and skills by introducing them to tools and concepts that enhance their effectiveness as communicators and teachers. We utilized an inquiry-based instructional approach to learn about physical 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, explanation/invention, practical applications, problem solving/case study, deduction-transfer of learning, and simulations and modeling). Students were encouraged to reflect on their class experience in blogs that were periodically reviewed by the instructors. The course was offered for two consecutive years. A website was created for the class and was populated with all the relevant material. These materials are available at: http://misclab.umeoce.maine.edu/boss/classes/SMS_491_2008/SMS_491_2008_index.htm, and are routinely downloaded.

(3) Publications: all the teaching materials and hands-on activities that were developed as part of this project became available to the general public via the publication of manuscripts and a collection of hands-on minds on activities. In the last year of the project we worked on the production of short videos that demonstrate these activities (available at http://cosee.umaine.edu/programs/courses/UMaine491/).

Findings:

Findings:

(1) Summer workshops:
For these workshops we received many requests from in ?state and out-of-state teachers. The main reasons for applying for the workshops, based on the application forms, were (1) interest in ocean systems, (2) interest in inquiry-based teaching and (3) luck of resources for hands-on activities/workshops on the physics and chemistry of the ocean which this workshop offers. We were able to accept about third of the applicants. Participants in the workshops represented a diverse group of teachers in terms of teaching experiences (e.g., # of years in the field; ranged from 1 to >20), school and classroom settings (e.g., grade level, size of schools and classrooms, population served, special needs), teaching subjects (e.g., physics, chemistry, environmental sciences, physical sciences, biology) and hence their need and interest in the program. We conducted a pre-workshop survey to gather information on participant's demographics, level of confidence in teaching specific science concepts and information on their current curriculum. This information was used in preparation for the workshop. An evaluation of the workshop was done at the end of each day to assess the value of each of the activities presented that day and on the final day of the workshop participants were asked to reflect upon their various experiences. Information from these surveys was used to refine the workshops from year to year.
Overall, participants indicated that all the workshops were highly successful in conveying scientific concepts related to marine sciences, praised the pedagogical applications and stated that they were relevant and directly transferable to their classrooms. They also noted that group discussions and lab summaries were instrumental in helping participants to understand the material.
Few examples of general comments in respond to a question about the satisfying aspects of the workshop:
? 'I loved the fact that we were given the opportunity to

explore the science concepts ourselves through inquiry. This is by far the best workshop/class I have participated in because of the connection between science and pedagogy and opportunity to experience it ourselves'.
? 'I've been caught up in teaching to the test always worried about time and have lost the exploratory aspect of science class. This workshop has helped me to rediscover what I love about science. I'd like to loosen up and allow my students to discover answers rather than have it handed to them.'
? 'I now have many resources, ideas and labs that I can use. Also, all of the physical applications are important to address so the students can make science concepts relate to their lives.
? 'Every session I learned something new about either physics, how to teach something in a better way or how to improve an activity I have already been using. The instructors + workshop participants were helpful and encouraging no matter what your level of understanding or skill. The DMC staff was great too'.
? 'I was challenged to think critically and look at the topics from a different perspective. I have learned a lot in science content and application.'

Examples of comments on areas for improvement included requests for additional activities on specific concepts, more discussion time, extend the number of days of the workshop, more lab time. We considered each of the criticisms carefully and applied 'lessons learned' from one summer to the next.
In response to a question regarding the likelihood of incorporating materials from the workshop into their lessons, all the teachers participated in the workshops indicated that they will change at least some of their teaching approach, strategies and content as a result of participating in the workshop. For example: 2007 workshop: in the pre-workshop survey all the teachers indicated that they teach the concept of density, but only half of them were teaching it in the context of ocean sciences. At the end of the workshop all teachers indicated that they will incorporate aspects of ocean sciences into their lesson on this topic. An important measure of the effectiveness of the workshop and its broader impact, however, is weather teachers did indeed incorporated ideas, concepts and activities presented in the workshop in their lesson plans and whether they share this information with their colleagues. One academic year after the workshops participants were sent an email asking them to respond to a final questionnaire to determine whether participants had incorporated changes in the content they taught (e.g., adding new concepts, incorporating ocean sciences into the curriculum), the instructional strategies they used and demonstrations they used in their classes. We have a small sample size to address this question; not all the teachers responded and some got different teaching assignments. Nevertheless, the responses that we got indicated that for most part the teachers were applying different aspects from their workshop in their teaching. About ? of the teachers that responded indicated that they added new concepts/content as a result of the workshop. Some of the participants specifically commented that they made effort to include more ocean content in their classes as a result of the workshop. All the teachers that responded to the survey indicated that they adapted instructional strategies and incorporated demonstrations from the workshop. Many of the participants indicated

that they now used inquiry-based teaching approach more often in their classroom and other have indicated that they have incorporated more labs and hands on activities. Teachers that already used hands-on/minds-on teaching approach have commented that as a result of the workshop they had new ideas to draw from. Finally most of the workshop participants who responded to the survey indicated that they shared knowledge and ideas gained in the workshops with their colleagues by distributing their workshop binders and via discussions during team meetings at their schools. Several participates have indicated that they encouraged their colleagues to participate in future COSEE workshops.
Finally, concepts and demonstrations developed for the workshops were adapted to other teacher development programs, not related to COSEE, for example the 'C's to Shining C: Connecting Climate to Curriculum' program (funded by the State of Maine).

(2) The college level course 'Teaching Physical Sciences by Ocean Inquiry' was offered for 2 consecutive years (2007 and 2008) and attracted both Education and Marine Science majors. Class sizes were small- 7 and 11 students in 2007 and 2008, respectively, but this small size class is typical for elective courses in the fields of marine sciences and science education at the University of Maine. The course was well received by the students. Based on the University of Maine's course evaluation the overall rating of the course was high (mean: 4.5 median: 5 on a scale of 1-5 where 1 is poor and 5 is excellent). We also conducted our own evaluation via weekly blogs and a pre- and post-course questionnaire. Students' blogs provided us with a continuous, weekly feedback throughout the semester and allowed us to closely monitor student's responses to and understanding of the material. Student responses on the pre- and post course questionnaire indicated that the main reason for choosing was to learn how to communicate science more effectively. This goal was met: all students indicated that as a result of the course they have acquired new skills to communicate science concepts in general and ocean concepts in particular. Several students commented that they already used some of the new skills when preparing presentations for other classes. Many students also indicated that the course had positively influenced the way they were thinking about teaching. Unfortunately we were not able to offer the class after spring 2008 due to the retirement, without a replacement, of Dr. Herman Weller, the science education expert in the program. The College of Education and Human Development at the University of Maine is still in the process of hiring a science education expert and we hope to continue and offer this course in the future.

(3) In collaboration with the Oceanography Society we published a supplement to the Oceanography magazine which contains a collection of hands-on/mind-on activities that were developed as part of this project (see publications below). The document generated much interest (one of the top 3 most downloaded documents from The Oceanography Society web site) not only among educators in the USA, but also among educators outside of the USA. We worked with colleagues in Belgium and Spain and the Oceanography Society on translations of the document to

French, Spanish and Catalan. These translations are now available online. The URLs for the translations are receiving many hits, demonstrating that outcomes from this project have broader impact on an international level.

Training and Development:

We have been actively engaged in training and development of pre-service and in-service science teachers through the workshops and the college-level course offered at the University of Maine. In addition we employed a graduate student (Ms. Jennifer Albright), who participated in all aspects of this project, from the design of the workshops and class to the dissemination of the products.

Outreach Activities:

By its nature, this project is an outreach project as it involves middle-school and highschool teachers.

Outreach presentations:
? Teaching physical concepts by ocean inquiry: reaching pre- and in-service teachers. Ocean Sciences meeting (February 2008), Orlando, FL.
? Teaching Science by ocean inquiry: bringing the ocean to the classroom. Ocean Sciences meeting (February 2008), Orlando, FL. (presented by Nancy Sills, a workshop participant)

Journal Publications

Boss, E. Karp-Boss, L. Jumars, P., "Settling of particles in aquatic environments: Low Reynolds numbers.", Oceanography, p. 145, vol. 19, (2006). Published,

Karp-Boss, Lee, E. Boss and J. Loftin, "Diffusion at work: an interactive simulation of diffusion", Oceanography, p. 127, vol. 20(3), (2007). Published,

Books or Other One-time Publications

Karp-Boss L, E. Boss, H. Weller, J. Loftin and J. Albright, "Teaching physical concepts in oceanography", (2009). special issue/supplement, Published Bibliography: Oceanography 22(3) supplement: 1-52 (available free online, including translations to Spanish, Catalan, and French: http://www.tos.org/hands-on/teaching_phys.html).

Web/Internet Site

URL(s):

(1) http://cosee.umaine.edu/workshop/index.php

(2)http://cosee.umaine.edu/programs/courses/UMaine 491/
(3)http://cosee.umaine.edu/programs/courses/UMaine 491/

Description:
(1)Summer Workshop materials
(2)A detailed syllabus and handouts for the semester course
(3) Videos with demonstrations of key physical concepts

Other Specific Products

Product Type:

Teaching aids

Product Description:

Teachers' Guide on how to align summer workshop science content with recognized
learning standards. This is a guide in matrix format to the alignment of the Summer Workshop
science content and laboratory exercises with the following recognized learning standards or scope and sequence: Maine Learning Results (Maine
Department of Education), National Science Education Standards (National
Research Council), Project 2061 Benchmarks for Scientific Literacy (American
Association for the Advancement of Science), and NSTA Scope and Sequence
of Secondary School Science (National Science Teachers Association).

Sharing Information:

Distributed to teachers during summer workshops

Contributions

Contributions within Discipline:

? A new collection of activities and approaches for teaching physical concepts in oceanography.
? Training/ professional development of in-service and pre-service teachers
? Increased visibility of the COSEE network on national and international levels through our work with in-service teachers and through publications.

Contributions to Other Disciplines:

Physics:
? A new collection of activities and approaches for teaching physical concepts using ocean related processes to convey these concepts.

Contributions to Human Resource Development:

The project has resulted in the creation of a new course, established a collaboration between the College of Education and the School of Marine Sciences. In addition, the course and the workshop have contributed to the development of a graduate student, Jennifer Albright, and provided her with both science and pedagogy tools and hands-on experience in teaching. She recently took a job as a science teacher in a high-school.

Contributions to Resources for Research and Education:

The UMaine COSEE-OS project created a network of summer workshop participants that will be drawn upon by an increasingly wider group of science educators in the future.

Contributions Beyond Science and Engineering:
None.

Conference Proceedings

Categories for which nothing is reported:

Any Conference

Final Report

Participant Individuals:
Co Principal Investigator(s): Lee Karp-Boss; Emmanuel S Boss
Other -- specify(s): Lori Smith
Graduate student(s): Jennifer Albright
Pre-college teacher(s): Nancy Sills; Tracy Vassiliev
Herman Weller

Partner Organizations:
Bigelow Laboratory for Ocean Sciences: In-kind Support; Facilities; Collaborative Research:

Bigelow Laboratory for Ocean Sciences - is focusing their efforts on editorial review of 'Oceans in the News' articles and scientific review of concept-based educational resources

Maine Mathematics and Science Alliance: In-kind Support; Facilities; Collaborative Research
Maine Mathematics and Science Alliance – continues to advise 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.

University of New Hampshire: In-kind Support; Facilities; Collaborative Research
University of New Hampshire (UNH) – has 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 'Climate and Oceans - Using Ocean Based Data' at UNH

Activities and findings:

Research and Education Activities:

During the course on of the project we designed and presented high-quality and science-based educational experiences that emphasize fundamental science concepts within an ocean context to ensure broader applicability (e.g., beyond the coasts). We adapted tools and resources that help to engage students in learning and developed a collection of hand-on/mind-on activities for teaching physical concepts in Oceanography, that can be used with a broad range of audience in both formal (middle school to college-level students) and informal (science museums, aquariums) settings.

Our team (Weller, Karp-Boss and Boss) efforts focused on three avenues for disseminating educational experiences and products:

(1) Summer workshops for in-service teachers ("Teaching Sciences by Ocean Inquiry"): During the summers of 2006-2008 we conducted a total of four, one-week long workshops for high-school and middle-school teachers who teach physics and physical sciences. Goals were to: a) 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 b) develop a network between teachers, scientists and experts in education. Teachers worked closely with program instructors to augment content-based knowledge in oceanography, develop teaching materials and means of assessments, and participated in pedagogy discussions on inquiry-based teaching and learning. A total of 58 teachers, from 16 different states participated in these workshops (ME (30), NY(6), NC(4), MA(2), NH (2), OH (2), SC(2), TN(2), AZ(1), FL(1), ID(1), KY(1), MO(1), NM(1), PA(1), VA(1)). About three quarters of the participants were from inland communities.

(2) A new, intedisciplinary, college level course for pre-service teachers and marine science majors. This course provided a unique opportunity for marine science students who are interested in incorporating an educational aspect to their science backgrounds. Whether they intend to be classroom teachers, research scientists, or informal educators, these students elected to make an investment in their future by learning strategies to effectively communicate ocean science. The course addressed several goals: 1) Introduce pre-service teachers to concepts in marine sciences, using inquiry based learning and teaching approaches, 2) help young marine scientists to more effectively communicate their subject and 3) create a greater awareness among scientists about the need for outreach. In several cases these students had initiated their own exploration in education by seeking out opportunities to teach science to young people and/or the public. With a more structured and formal approach, this course helped them to refine and reflect on their educational interests and skills by introducing them to tools and concepts that enhance their effectiveness as communicators and teachers. We utilized an inquiry-based instructional approach to learn about physical 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, explanation/invention, practical applications, problem solving/case study, deduction-transfer of learning, and simulations and modeling). Students were encouraged to reflect on their class experience in blogs that were periodically reviewed by the instructors. The course was offered for two consecutive years. A website was created for the class and was populated with all the relevant material. These materials are available at: http://misclab.umeoce.maine.edu/boss/classes/SMS_491_2008/SMS_491_2008_index.htm, and are routinely downloaded.

(3) Publications: all the teaching materials and hands-on activities that were developed as part of this project became available to the general public via the publication of manuscripts and a collection of hands-on minds on activities. In the last year of the project we worked on the production of short videos that demonstrate these activities (available at http://cosee.umaine.edu/programs/courses/UMaine491/).

Findings:

(1) Summer workshops:
For these workshops we received many requests from in –state and out-of-state teachers. The main reasons for applying for the workshops, based on the application forms, were (1) interest in ocean systems, (2) interest in inquiry-based teaching and (3) luck of resources for hands-on activities/workshops on the physics and chemistry of the ocean which this workshop offers. We were able to accept about third of the applicants. Participants in the workshops represented a diverse group of teachers in terms of teaching experiences (e.g., # of years in the field; ranged from 1 to >20), school and classroom settings (e.g., grade level, size of schools and classrooms, population served, special needs), teaching subjects (e.g., physics, chemistry, environmental sciences, physical sciences, biology) and hence their need and interest in the program. We conducted a pre-workshop survey to gather information on participant's demographics, level of confidence in teaching specific science concepts and information on their current curriculum. This information was used in preparation for the workshop. An evaluation of the workshop was done at the end of each day to assess the value of each of the activities presented that day and on the final day of the workshop participants were asked to reflect upon their various experiences. Information from these surveys was used to refine the workshops from year to year.

Overall, participants indicated that all the workshops were highly successful in conveying scientific concepts related to marine sciences, praised the pedagogical applications and stated that they were relevant and directly transferable to their classrooms. They also noted that group discussions and lab summaries were instrumental in helping participants to understand the material.
Few examples of general comments in respond to a question about the satisfying aspects of the workshop:

- "I loved the fact that we were given the opportunity to explore the science concepts ourselves through inquiry. This is by far the best workshop/class I have participated in because of the connection between science and pedagogy and opportunity to experience it ourselves".
- "I've been caught up in teaching to the test always worried about time and have lost the exploratory aspect of science class. This workshop has helped me to rediscover what I love about science. I'd like to loosen up and allow my students to discover answers rather than have it handed to them."
- "I now have many resources, ideas and labs that I can use. Also, all of the physical applications are important to address so the students can make science concepts relate to their lives.
- "Every session I learned something new about either physics, how to teach something in a better way or how to improve an activity I have already been using. The instructors + workshop participants were helpful and encouraging no matter what your level of understanding or skill. The DMC staff was great too".
- "I was challenged to think critically and look at the topics from a different perspective. I have learned a lot in science content and application."

Examples of comments on areas for improvement included requests for additional activities on specific concepts, more discussion time, extend the number of days of the workshop, more lab time. We considered each of the criticisms carefully and applied 'lessons learned' from one summer to the next.

In response to a question regarding the likelihood of incorporating materials from the workshop into their lessons, all the teachers participated in the workshops indicated that they will change at least some of their teaching approach, strategies and content as a result of participating in the workshop. For example: 2007 workshop: in the pre-workshop survey all the teachers indicated that they teach the concept of density, but only half of them were teaching it in the context of ocean sciences. At the end of the workshop all teachers indicated that they will incorporate aspects of ocean sciences into their lesson on this topic. An important measure of the effectiveness of the workshop and its broader impact, however, is weather teachers did indeed incorporated ideas, concepts and activities presented in the workshop in their lesson plans and whether they share this information with their colleagues. One academic year after the workshops participants were sent an email asking them to respond to a final questionnaire to determine whether participants had incorporated changes in the content they taught (e.g., adding new concepts, incorporating ocean sciences into the curriculum), the instructional strategies they used and demonstrations they used in their classes. We have a small sample size to address this question; not all the teachers responded and some got different teaching assignments. Nevertheless, the responses that we got indicated that for most part the teachers were applying different aspects from their workshop in their teaching. About ¾ of the teachers that responded indicated that they added new concepts/content as a result of the workshop. Some of the participants specifically commented that they made effort to include more ocean content in their classes as a result of the workshop. All the teachers that responded to the survey indicated that they adapted instructional strategies and incorporated demonstrations from the workshop. Many of the participants indicated that they now used inquiry-based teaching approach more often in their classroom and other have indicated that they have incorporated more labs and hands on activities. Teachers that already used hands-on/minds-on teaching approach have commented that as a result of the workshop they had new ideas to draw from. Finally most of the workshop participants who responded to the survey indicated that they shared knowledge and ideas gained in the workshops with their colleagues by distributing their workshop binders and via discussions during team meetings at their schools. Several participates have indicated that they encouraged their colleagues to participate in future COSEE workshops.

Finally, concepts and demonstrations developed for the workshops were adapted to other teacher development programs, not related to COSEE, for example the "C's to Shining C: Connecting Climate to Curriculum" program (funded by the State of Maine).

(2) The college level course 'Teaching Physical Sciences by Ocean Inquiry' was offered for 2 consecutive years (2007 and 2008) and attracted both Education and Marine Science majors. Class sizes were small- 7 and 11 students in 2007 and 2008, respectively, but this small size class is typical for elective courses in the fields of marine sciences and science education at the University of Maine.

The course was well received by the students. Based on the University of Maine's course evaluation the overall rating of the course was high (mean: 4.5 median: 5 on a scale of 1-5 where 1 is poor and 5 is excellent). We also conducted our own evaluation via weekly blogs and a pre- and post-course questionnaire. Students' blogs provided us with a continuous, weekly feedback throughout the semester and allowed us to closely monitor student's responses to and understanding of the material. Student responses on the pre- and post course questionnaire indicated that the main reason for choosing was to learn how to communicate science more effectively. This goal was met: all students indicated that as a result of the course they have acquired new skills to communicate science concepts in general and ocean concepts in particular. Several students commented that they already used some of the new skills when preparing presentations for other classes. Many students also indicated that the course had positively influenced the way they were thinking about teaching. Unfortunately we were not able to offer the class after spring 2008 due to the retirement, without a replacement, of Dr. Herman Weller, the science education expert in the program. The College of Education and Human Development at the University of Maine is still in the process of hiring a science education expert and we hope to continue and offer this course in the future.

(3) In collaboration with the Oceanography Society we published a supplement to the Oceanography magazine which contains a collection of hands-on/mind-on activities that were developed as part of this project (see publications below). The document generated much interest (one of the top 3 most downloaded documents from The Oceanography Society web site) not only among educators in the USA, but also among educators outside of the USA. We worked with colleagues in Belgium and Spain and the Oceanography Society on translations of the document to French, Spanish and Catalan. These translations are now available online. The URLs for the translations are receiving many hits, demonstrating that outcomes from this project have broader impact on an international level.

Training and Development:

We have been actively engaged in training and development of pre-service and in-service science teachers through the workshops and the college-level course offered at the University of Maine. In addition we employed a graduate student (Ms. Jennifer Albright), who participated in all aspects of this project, from the design of the workshops and class to the dissemination of the products.

Outreach Activities:

Outreach presentations:

- Teaching physical concepts by ocean inquiry: reaching pre- and in-service teachers. Ocean Sciences meeting (February 2008), Orlando, FL.
- Teaching Science by ocean inquiry: bringing the ocean to the classroom. Ocean Sciences meeting (February 2008), Orlando, FL. (presented by Nancy Sills, a workshop participant)

Journal Publications:

Boss, E., L. Karp-Boss, and P.A. Jumars, 2006. "Settling of Particles in Aquatic Environments", *Oceanography*, 19(2): 151-154.

Karp-Boss, Lee, E. Boss and J. Loftin, 2007. "Diffusion at work: an interactive simulation of diffusion", *Oceanography*, 20(3):127-131.

Web sites

All the material from the workshops and semester course is available on the COSEE-OS web site.

Summer Workshop: http://cosee.umaine.edu/workshop/index.php

A detailed syllabus and handouts for the semester course can be found at:

http://cosee.umaine.edu/programs/courses/UMaine491/

Videos with demonstrations of key physical concepts are posted at:

http://cosee.umaine.edu/programs/courses/UMaine491/

Book(s) of other one-time publications(s):

*Karp-Boss L, E. Boss, H. Weller, J. Loftin and J. Albright. 2009. Teaching physical concepts in oceanography. *Oceanography* 22(3) supplement: 1-52 (available free online http://www.tos.org/hands-on/teaching_phys.html).

Spanish, Catalan and French translations: http://www.tos.org/hands-on/teaching_phys.html

Other Specific Products:

Teaching aids

Teachers' Guide on how to align summer workshop science content with recognized learning standards. This is a guide in matrix format to the alignment of the Summer Workshop science content and laboratory exercises with the following recognized learning standards or scope and sequence: Maine Learning Results (Maine Department of Education), National Science Education Standards (National Research Council), Project 2061 Benchmarks for Scientific Literacy (American Association for the Advancement of Science), and NSTA Scope and Sequence of Secondary School Science (National Science Teachers Association).

Contributions:

Contributions within Discipline:

- A new collection of activities and approaches for teaching physical concepts in oceanography.
- Training/ professional development of in-service and pre-service teachers
- Increased visibility of the COSEE network on national and international levels through our work with in-service teachers and through publications.

Contributions to Other Disciplines:

Physics:

- A new collection of activities and approaches for teaching physical concepts using ocean related processes to convey these concepts.

Contributions to Education and Human Resources:

The project has resulted in the creation of a new course, established a collaboration between the College of Education and the School of Marine Sciences. In addition, the course and the workshop have contributed to the development of a graduate student, Jennifer Albright, and provided her with both science and pedagogy tools and hands-on experience in teaching. She recently took a job as a science teacher in a high-school.

Contributions to Resources for Science and Technology:

The UMaine COSEE-OS project created a network of summer workshop participants that will be drawn upon by an increasingly wider group of science educators in the future.

Contributions Beyond Science and Engineering:

None.

Special Requirements for Annual Project Report:

Categories for which nothing is reported:
Participants: Other Collaborators
Special Reporting Requirements
Animal, Human Subjects, Biohazards

Annual report Y3

Participant Individuals:
Co Principal Investigator(s): Lee Karp-Boss; Emmanuel S Boss
Other -- specify(s): Lori Smith
Graduate student(s): Jennifer Albright
Pre-college teacher(s): Nancy Sills; Tracy Vassiliev

Partner Organizations:
Bigelow Laboratory for Ocean Sciences: In-kind Support; Facilities; Collaborative Research:

Bigelow Laboratory for Ocean Sciences - is focusing their efforts on editorial review of 'Oceans in the News' articles and scientific review of concept-based educational resources

Maine Mathematics and Science Alliance: In-kind Support; Facilities; Collaborative Research
Maine Mathematics and Science Alliance – continues to advise 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.

University of New Hampshire: In-kind Support; Facilities; Collaborative Research
University of New Hampshire (UNH) – has 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 'Climate and Oceans - Using Ocean Based Data' at UNH

Activities and findings:

Research and Education Activities:

During Year 3 of COSEE-OS we continued our efforts in providing high-quality and science-based educational experiences, tools, and resources that emphasize fundamental science concepts within an ocean context, building upon the experience we gained in the past two years. Our team (Weller, Karp-Boss and Boss) efforts continued focusing on our two major objectives:

(1) 'Teaching Sciences by Ocean Inquiry' Workshop (2nd workshop: July 23-27, 2007): This week-long workshop for in-service teachers (13 middle-school and high-school teachers participated in the workshops) explored the dynamics of teaching science using ocean examples. Focus was placed on physical science concepts such as density, pressure, buoyancy, heat and temperature and waves Goals were to: a) help teachers develop inquiry-based units for teaching these concepts, using oceans and their climate links as a vehicle; and b) develop a network between teachers, scientists and experts in education.

Teachers worked closely with program instructors to develop hands-on activities, teaching materials, and means of assessment (to address educational standards) and participated in discussions on inquiry-based teaching. Daily and summative questionnaires provided the data for an extensive evaluation report (L. smith 2007). Building upon the evaluations of last year's workshop (2006) we improved the design and efficacy of the workshop:

- We added an educational 'Preface' (presentation and discussion) at the beginning of each day (before the lecture/discussion and laboratory activities started). Topics concerned the 'Nature of Science' especially Inquiry and the 'Nature of Teaching Science Via Inquiry.' These sessions seemed to set the tone for the day's activities, and were well received by the participants.
- A pedagogy wrap-up was also added after the day's activities. The participants expressed appreciation for the merging of inquiry science pedagogy and science content.
- Lecture and instructions for activities were improved. Each teacher received a folder and a CD containing handouts with detailed instructions for activities, explanations for the activities, science background and pedagogy notes.

A website was created for the workshop and was populated with all the relevant material. These materials are available at: http://cosee.umaine.edu/workshop/index.php, and are routinely downloaded.

(2) 'Teaching Physical Sciences by Ocean Inquiry' Course
(Spring semester 2008): This interdisciplinary course brings together marine science majors who are interested in incorporating an educational aspect to their science backgrounds and science education majors (pre-service teachers). The course addressed several goals: 1) introduce pre-service teachers to basic physical concepts and concept in ocean sciences, using inquiry based learning and teaching approach; 2) help young marine scientists to more effectively communicate their subject; 3) encourage science majors to pursue professions where they simultaneously serve science and education; and 4) create a greater awareness among scientists about the need for outreach. We applied lessons learned from the pilot course that we offered in 2006 and improved the design and efficacy of this semester course. This year, the total number of students in the course increased to 11. There were three Science Education students (one undergraduate and two graduate students) and eight Marine Sciences students (seven undergraduates and one graduate student). The students were grouped into 3-4 person teams, each including one Science Education student. The 'cross-fertilization' of knowledge, ideas, and skills between SMS and Education students was quite beneficial to all students in each group.

Each week on Tuesdays, the students performed hands-on inquiry-based laboratory activities. A pedagogy introduction was added at the beginning of each Tuesday section (e.g., Discrepant Event, Prediction, Exploration, Hypothesizing, Inventing Explanations, Application, Problem Solving, Case Study). On Wednesdays, the pedagogy applications of the previous Tuesday were discussed. Each Wednesday a different student presented a typical education or science education technique chosen from the following: e.g., Advance Organizer, Demonstration, Imagery, Analogistic Thinking, Synectics, Positive

vs. negative Exemplars of a Concept, Deductive Activities, Concept Mapping, Vee Heuristic, Mnemonic Devices, Concept Circles, and Science Projects. In evaluations, the students commented quite favorably about these presentations.

A weekly 'blog' commentary was required of each student.
This replaced the written journal comments of the previous year's course. Each student was required to comment on the positive and negative aspects of the science activities and the pedagogy activities. The course instructors responded on the blog website to each of the student blogs. 75% of the students were quite punctual and expressive in their blogs.

At the end of the course, each student created as a Final Project a teaching unit plan that taught physical science concepts in an inquiry, hands-on manner that incorporated several pedagogy and science ideas from the course. Each student presented a 15-20 minute hands-on learning portion of his or her unit plan to the class. This replaced the Lesson Plan of the previous year's course.

Note: The course has been taught for two years on 'temporary' course numbers in the SMS and Education units. In spring 2008, the course was presented to the UMaine Curriculum Committee as a General Education 'applications of science' course with the course number ESC 400. It was accepted by the Curriculum Committee. This should increase the course's appeal to SMS, Education, and Other-major undergraduate students, because all UMaine undergraduates are required to take an 'applications of science' General Education course. The ESC 400 course number should also enable the course to attract both undergraduates and graduate students, because a 400-level course may be counted in a master's program.

A website was created for the class and was populated with all the relevant material. These materials are available at:
http://misclab.umeoce.maine.edu/boss/classes/SMS_491_2008/SMS_491_2008_index.htm, and are routinely downloaded.

(3) 'Teaching Sciences by Ocean Inquiry' Summer Teacher
Workshops (July 21-25, and July 28 - August 1. 2008): The large number of applications (60) from science educators in 19 states stretching completely across the United States (AZ, CT, FL, ID, GA, KY, MA, MD, ME, NC, NH, NM, NY, OH, TN, TX, VA, VT, and WA) was astounding! Many of these applicants are teaching in inland and/or 'landlocked' schools. We were able to restructure our funding so that we could present two successive one-week workshops, each for 15 participants. We are currently preparing for these two workshops.

The focus and goals of each workshop will remain the same.
We will even more closely intertwine the pedagogy and science content aspects of each day than in the previous two summer's workshops.

Findings:

(A) 'Teaching Sciences by Ocean Inquiry' Workshop (July 23-27, 2007):
For this workshop we received many requests from out-of-state teachers (the workshop was originally designed for teachers in Maine). As a result, we accepted 5 teachers from Maine and 10 teachers from out-of-state (MA, VA, NY (2), NC (2), SC (2) and GA (2). The main reasons for applying for the workshop, based on the application forms, were (1) interest in ocean systems, (2) interest in inquiry-based teaching and (3) luck of resources for hands-on activities/workshops on the physics and chemistry of the ocean which this workshop offers. Several applicants indicated that there are several workshops and many resources for teaching aspects of marine biology but very few for teaching physical/chemical aspects of the ocean.
Participants were asked to reflect on their workshop experience and whether their teaching approach/strategies will change as a result. Respondents rated the likelihood of incorporating changes into their lessons along a scale that ranged from *Will not change at all* to *Will change some* to *Will change significantly*. 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. Nine of these twelve respondents stated it would change significantly. When asked to briefly explain their responses and which aspects of their teaching approach/strategies will change, the lab activities were most frequently mentioned as contributing to their decision.

- Example: "I will most definitely include the lab activities that we did this week with my classes. I appreciate the easily transferable lab activities and the way I can use them to increase my students understanding of these topics."

Workshop participants were also asked about their most satisfying aspect(s) of this workshop. Again, the hands-on lab experiences were frequently mentioned. Respondents also praised the daily discussions, which helped their understanding.

- Example: "I loved the fact that we were given the opportunity to explore the science concepts ourselves through inquiry. This is by far the best workshop/class I've participated in because of the connection between the science and pedagogy and opportunity to experience it ourselves.

Lastly, 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. One mentioned the fullness of materials presented on the first two days and suggested spreading these concepts out to even the pace. Two respondents recommended including a boat trip in the workshop.

- Examples: "More post lab to allow experienced teachers to enlighten lesser experienced on the pluses, additions, or subtractions to these labs. All and all the teachers were enlightened, excited, and invigorated by this workshop. One of the best I have seen."

In addition, participants in the summer 2006 workshop, *Teaching Science by Ocean Inquiry*, were asked to participate in a follow-up questionnaire to determine whether they

had incorporated changes in the content they taught or the instructional strategies and demonstrations they used in their classrooms as a result of participating in the workshop. Fourteen middle and high school teachers participated in the 2006 summer workshop, and twelve responded to the follow-up questionnaire.

Workshop participants were asked whether they had made any changes to the content of the courses they taught as a result of their participation in the summer workshop. Eight of the 12 respondents indicated that they had made changes to course content

- I have added some oceanography topics to the physics portion of the integrated science class that I teach. Notably, I put more emphasis on scattering of light (vs. reflection or transmission or absorption) than in past years, using the lab and reference to particulates and dissolved particles in the water as our focus.
- I have been able to add a variety of topics to my curriculum based on the workshop. I have especially focused on adding segments which use the real-time data that I was made aware of online through the workshop.
- The COSEE workshop helped me tremendously with a new teaching assignment I received for the 2006-2007 year (Accelerated Physical Science). Because of the COSEE workshop I was able to implement several ocean inquiry activates with confidence:
    - Invasive Crab Research Project (timed transects at Moose Point State Park).
    - Buoyancy with phytoplankton and zooplankton (increase the buoyancy of a marble, slowest sinking time wins).
    - Density inquiry and weather tanks.
    - Pascal (Cartesian Diver).
    - Boyles & Dalton's Law with intro to SCUBA at Maine Maritime Academy.
    - Seafloor mapping activity (3D mapping with card stock).
- The format of the COSEE workshop encouraged me to begin my half-year applied chemistry course with a more thorough exploration of density, since this topic is relevant to many topics in chemistry. In this unit, I also briefly introduced some concepts relating to oceanography and weather patterns.

When asked whether they had made changes in the instructional strategies, all but one of the respondents stated they had made changes in their instructional strategies after participating in the summer workshop.

- I do more hands on assignments and increased the technical difficulty of my classes. Students are required to find answers to problems without a set answer. Also I started using word webs more often in my instruction.
- I have tried to adjust the way I use discrepant events and demonstrations in my courses. Instead of first soliciting student responses and steering the discussion in the right discussion, I have tried to leave the discussion more open ended and then provided ways for students to refine their explanations.
- I've used some of the lab activities I saw at the workshop, particularly the ones related to understanding density.
- This was the area in which the workshop was the most useful. Specifically the idea of discrepant events as a jumping off point for student based questions and

more open-ended and unstructured investigations in labs. I have also incorporated more simple predict-observe-explain type activities.

- We will be making use of the Epstein "scratch multiple choice" pads this semester as a way to get small groups thinking about conceptual questions.

Workshop participants were asked in the follow-up questionnaire to whether they had shared knowledge gained at the workshop with other colleagues. Nine of the twelve respondents stated they had shared knowledge gained from the workshop with other colleagues, and one had recommended the workshop to a colleague. One of the three respondents who had not shared information stated that two other colleagues from the same institution were present at the workshop, so they were well represented. Furthermore, two respondents, one had shared information and one had not, indicated that busy schedules made it difficult to find time to share information with other colleagues. Interaction between the instructors and many of the participants continued after the workshops. One participant (Tracy Vassiliev, 2006 workshop) was selected to give a presentation about this workshop at the 2007 National Marine Educators Association conference in Portland, ME. Another participant (Nancy Sills, 2007 workshop) was invited to give a presentation at the Ocean Sciences meeting in Orlando FL (2008). A third participant, Ted Taylor (Bangor High, ME) and his students, began collaboration with Karp-boss and Boss on a monitoring program at Pushaw Lake, Maine.

(B) 'Teaching Physical Sciences by Ocean Inquiry' Course (spring semester 2008): The course attracted more Education (3) and SMS (8) students than the previous year. It also attracted more Education (1) and SMS (1) graduate students than the previous year.

The student comments on the electronic 'blog' were for 75% of the students far longer and far more reflective than the journal reflections of the previous year's course. Even the three students who had apparent difficulty in being punctual with their blogs and in writing a great deal in their blogs, wrote blogs that were superior to most of the journal writings of the previous year.

The student Unit Plans, and their presentations of portions of them, were much superior to most of the Lesson Plans of the previous year's course.

The course was well received by the students. Based on the University of Maine's course evaluation the overall rating of the course was high (mean: 4.5 median:5 on a scale of 1-5 where 1 is poor and 5 is excellent). We also conducted our own evaluation were students were asked to reflect upon their experience. Their responses are currently being processed (L. Smith, in preparation), as well as the 'one-year-later' follow-up student evaluation data of the spring 2007 course (L. Smith, in preparation).

Students' blogs provided us with a continuous, weekly feedback throughout the semester and allowed us to closely monitor student's responses to and understanding of the material. At the middle of the semester students were asked to reflect upon their experience during the first half of the semester in their blogs. We provide examples from 4 students (2 SMS and 2 education majors):

“So far, in the past seven weeks, I have definitely learned a lot about teaching methods. I think the most interesting thing I have learned so far is that assessment and teaching in general is way harder than I thought. There are a lot of things that a teacher has to think about like what kind of learner a student is, how to get students interested in the activity or lesson, and getting students to predict and explain things. I have also learned how to look at science concepts from a teaching perspective instead of just a learning perspective.” (Marine Science major, undergrad)

“The last seven weeks have been amazing. In terms of science, we have focussed so far on primarily physical concepts. Physics, although interesting, has never been something at which I considered myself really gifted. This class has helped me get a better grasp on most of the concepts that we discussed. I feel that I have a better and more fundamental understanding of the concepts, as well as a better idea of how they fit together and are interrelated. This is handy for me because the more connections I can make between things the more likely I am to remember them. During the first class it was mentioned that so many teachers teach science as something to learn by rote. As a student, people are seldom exposed to actual scientific practices and they seldom get a chance to do anything more than verification 'science'. I now have a better understanding of the difference between verification science and discovery science or science by inquiry, and I can say categorically that I prefer the latter…. In terms of pedagogy, this class has been a real eye-opener. I had no real idea of what teachers actually did before I signed up for this class. I also had absolutely no idea why they did what they did, other than a vague notion that it was required by some governmental or other oversight body. The actual reasons are fascinating. Education is definitely a field that I want to know more about.” (Marine Science major, grad student)

“I have found that my own concepts of science and education have been more strongly enforced over the first 7 weeks of the class. I have always felt that science is more complex than a simple set of instructions and rules to learn by, and teaching by inquiry is certainly far more complex than simple instruction. Science-wise I have been making more connections between concepts than I had before. Often times it is enough of a struggle to learn a concept that it would be impossible to connect it to other concepts without using too much valuable time (at least that is what I generally get the feeling of in most classrooms, personally I think there's always time). Being able to review concepts and place them in useful settings is certainly beneficial for my learning and is helping me think of ways to teach the concepts to students.” (Science education major, undergrad)

“This course has definitely made me reexamine what I know about several concepts in science and how I feel about physical science. I have always been more attracted to the biological side of science, and I have been taking biology-based courses since early high school. I have always viewed the physical concepts as rather boring and thus have not focused much attention on them. However, after 7 weeks of this course, I am realizing a few things…physical science is not as boring as I used to think. I don’t know if that is a function of the activities that we do in class, or it is a function of me being older and more mature in my study of science (it’s probably a combination). Another thing that I have come to realize is that the teaching of the biological side of marine science can be

greatly enhanced by a firm grasp of the physical science side. If you're going to talk about fish, you need to understand their physical environment. You need to know about density, salinity, buoyancy, etc." (Science education major, grad student).

Training and Development:

We have been actively engaged in training and development of pre-service and in-service science teachers through July workshops for practicing teachers and spring semester courses offered at UMaine for undergraduates and graduates.

Outreach Activities:

Outreach presentations:

- Teaching physical concepts by ocean inquiry: reaching pre- and in-service teachers. Ocean Sciences meeting (February 2008), Orlando, FL.
- Teaching Science by ocean inquiry: bringing the ocean to the classroom. Ocean Sciences meeting (February 2008), Orlando, FL. (presented by Nancy Sills, a workshop participant)

Journal Publications:

Boss, E., L. Karp-Boss, and P.A. Jumars, 2006. "Settling of Particles in Aquatic Environments", *Oceanography*, 19(2): 151-154.
Karp-Boss, Lee, E. Boss and J. Loftin, "Diffusion at work: an interactive simulation of diffusion", *Oceanography*, 20(3):127-131.

Web sites

All the material from the workshops and semester course is available on the COSEE-OS web site.

Summer Workshop: http://cosee.umaine.edu/workshop/index.php

A detailed syllabus and handouts for the semester course can be found at:

http://cosee.umaine.edu/about.php#tpsoi

Book(s) of other one-time publications(s):

Other Specific Products:

Teaching aids
Teachers' Guide to Alignment of Summer Workshop Science Content with Recognized Learning Standards.

This is a guide in matrix format to the alignment of the Summer Workshop science content and laboratory exercises with the following recognized learning standards or scope and sequence: Maine Learning Results (Maine Department of Education), National Science Education Standards (National Research Council), Project 2061 Benchmarks for Scientific Literacy (American Association for the Advancement of Science), and NSTA Scope and Sequence of Secondary School Science (National Science Teachers Association).
The Alignment Guide will be given to all 15 summer workshop participants.

Contributions:

Contributions within Discipline:

COSEE Network-related meetings and working groups contribute within the project's disciplines:
'Communicating Ocean Sciences Summer Workshop from COSEE-CA' (11-12 June 2007).

Contributions to Other Disciplines:

The course we offered has led to a dialog with an Assistant Professor at the Physics department at the University of Maine, whose work focuses on physics Education Research, including research-based curriculum development.
He visited our class several times to observe our activities and collaboration for a curriculum development proposal is currently being discussed.

Contributions to Education and Human Resources:

Thus far the project has established strong collaboration between the College of Education and the School of Marine Sciences. In addition, the course and the workshop have contributed to the development of a graduate student, Jennifer Albright, and provided her with both science and pedagogy tools and hands-on experience in teaching.

Contributions to Resources for Science and Technology:

Thus far the UMaine COSEE-OS project created a network of summer workshop participants that will be drawn upon by an increasingly wider group of science educators in the future.

Contributions Beyond Science and Engineering:

None.

Special Requirements for Annual Project Report:

Categories for which nothing is reported:

Participants: Other Collaborators
Products: Book or other one-time publication
Products: Internet Dissemination (see above)

Special Reporting Requirements
Animal, Human Subjects, Biohazards

OBJECTIVES AND SCOPE

The lead PI on this project (Weller) will retire in August 2008 and the two co-PI will be on sabbatical next year. As a result we revised the scope of our work for next year (this revision has been discussed with program manager Lisa Rom). The workshop planned for 2009 will be conducted in summer 2008 (2 workshops instead of the originally planned one workshop). The spring semester class will not be offered; instead we will focus on a publication containing hands on activities from the workshops and classes we offered. The publication will be produced by the Oceanography Society (TOS) and will become available to its members. The publication will also become available to science teacher and will be distributed at NSTA meetings.