COSEE Engagement of the Ocean Research Community

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Abstract- Over the last decade, the National Centers of Ocean Sciences Education Excellence (COSEE) Network has engaged ocean scientists and engineers in a variety of broader impact activities. COSEE has 1) identified effective practices for working with ocean scientists and engineers to improve their broader impacts activities, 2) developed and implemented a Scientists Survey to measure the impact of COSEE activities on the ocean sciences research community, and 3) identified the challenges of engaging scientists and engineers in broader impacts activities.

***Index Terms* – Education, outreach, broader impacts**

I. Introduction

Since 2002 the National Science Foundation (NSF) has funded an effort to develop a nation-wide network of Centers focused on improving ocean sciences education by involving ocean researchers and educators in broader impact activities. The sixteen COSEE Centers funded over the last decade were either regionally based or thematically focused. The NSF also funded a national hub, the National COSEE Office, which coordinated the growing COSEE Network. COSEE is currently one of the country's largest networks of ocean scientists and educators.

Each COSEE Center is comprised of a suite of partners that include ocean science institutions and researchers, and formal and informal education institutions.

Each Center focuses on a series of core activities that allow researchers to broaden the impact of their research. This is accomplished through professional development for researchers and educators, opportunities for researchers to interact with a variety of audiences, and dissemination of ocean science research products and tools. All of these activities are intended to increase the understanding of the ocean.

COSEE's support for scientists and engineers has taken multiple forms, depending upon the COSEE Center and the audience being served:

1) professional development for scientists and engineers to support their engagement in education, outreach, and communication of science;
2) development of tools for use in education, outreach, and communication activities; and
3) assistance with establishing collaborations and partnerships to ensure successful broader impacts of research.

This paper provides an overview of the accomplishments of the National COSEE Network with respect to the engagement of scientists and engineers in education and outreach and discusses the impact of COSEE's activities.

II. Effective Practices

A. Understanding motivation and investment in broader impacts

It is important to understand researchers' motivations for engaging in broader impacts so their needs can be met during the process. Some participate in broader impacts improvement programs and workshops because they want to improve their overall communication skills. They may have a specific goal (e.g. presenting research results to a specific audience). Others may be socially motivated, have children in a school with which they would like to work, or may be simply satisfying a grant or institutional requirement. Understanding the scientist's underlying motivation and end goals will help structure a path to achieve their goals. This structured path should be viewed as a worthwhile investment of scientists' resources (time, money and effort) to advance the public understanding of their research. If well structured, this path should also include motivations for increasing broader impacts

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goals, communication and implementation skills, and level of future efforts.

B. Length of time of engagement

The length of time that a researcher is engaged is highly correlated with their benefits gained. Across the COSEE Network, a significant amount of time and resources have gone into multi-day, residential, face-to-face scientist engagement programs, and most COSEE Centers (10 out of 12) conduct these types of programs. Over half the Centers are also conducting multi-day, non-residential programs, and most face-to-face programs are followed by online interactions.

The first engagement may be small, a low investment on the part of the researcher; and that is a good start, because it takes an investment of resources to develop the skills of:

- learning how to effectively communicate scientific research to other researchers
- crafting sound broader impact plans for proposals
- preparing graduate students to effectively communicate scientific research
- increasing capacity to effectively communicate scientific research with non-scientists
- developing strategies for citizen science programming
- reaching a more diverse audience when recruiting students for ocean sciences careers

C. Examples of Professional Development Programs and Tools for Education and Outreach

Programs to assist researchers with their improvement of broader impact activities are diverse across the Network. Audience types are a key factor with some Centers providing professional development for scientists to work with adult learners, informal science audiences, K-12 educators, media, the general public, etc. Providing professional development experiences for working with specific audiences circles back to establishing motivation and understanding the needs of researchers when working with the various audience types.

For example, one model is the COSEE Ocean Systems Concept Mapping Workshop for scientists and educators. The model has three phases: a collaboration phase; a peer to peer phase, where scientists present science and then high school teachers provide feedback on how the scientists can improve their presentations; and a reconnection phase, where the scientists revisit the original concept maps, which they developed, and apply them to a new situation. This model is currently being expanded to include training for the scientists on how to blog effectively. In this model, both the scientists and teachers are also trained to use software that involves building the concept map. Once the maps are created and adjusted based on the teachers' feedback, they are posted on an interactive website, where pieces of one map can link to other ocean science concepts. Others can access the maps and adapt them for their own use. In this model the scientists clearly see the value of their participation, both to themselves and others. (http://cosee.umaine.edu/tools/cmb/)

The COSEE California Communicating Ocean Sciences Course is another example of a successful scientist engagement model. It exposes the scientists, primarily graduate students, to learning theory and the nature of science. A key ingredient of this model is that the scientists are part of the course planning for the content that they will deliver. This course has been adopted by many COSEE Centers and other institutions across the country. COSEE Networked Ocean World (COSEE NOW) has adapted the course to reach 4H audiences. The COSEE CA team, in partnership with COSEE West and COSEE Pacific Partnerships (COSEE PP), has adapted the full 16-week course to train the national cadre of Knauss Fellows. (http://www.coseeca.net/programs/communicatingoceansciences/)

It is important for ocean researchers to come away from their participation in education and outreach activities having professionally benefitted themselves. The effective programs identified by the COSEE PIs provide ocean researchers with training on effective and interactive instructional methods and tools; exposure to new curriculum materials that they can use with their own students; introduction to new assessment strategies; and training on delivering effective webinars.

D. Partnerships and Guidance

In addition to offering professional development workshops, COSEE Centers have worked with hundreds of ocean researchers to offer guidance when preparing broader impact statements for proposals, and partnering with the researchers to deliver broader impact activities. In some cases the COSEE Centers have existing programs into which researchers can "plug in" their research topic, such as summer programs for teachers, webinars, and programs for the public in aquariums and science centers.

III. COSEE IMPACTS

In addition to individual COSEE Center evaluations, significant efforts were made to evaluate the impact of National COSEE Network. The Network evaluation was conducted by a team comprised of the evaluators from the individual COSEE Centers. Much of their effort focused on developing an instrument to assess impacts on participating ocean scientists - the COSEE Scientists Survey. This survey has been administered

to hundreds of scientists annually for the last three years.

The survey was distributed to all researchers in contact with COSEE Centers and the National Office, who were invited to complete the survey. Highlights extracted from the survey results include:

1. Respondents indicated that COSEE had a positive impact on their professional responsibilities, including education and outreach, college-level teaching, and research.
2. Scientists' thinking about research, teaching and education and outreach is evolving—in part due to involvement with COSEE.
3. Their quality and quantity of education and outreach increased because of COSEE.
4. Respondents report that their college-level teaching improved.
5. Length and type of affiliation with COSEE influenced the degree to which COSEE impacted respondents' professional activities.
6. Respondents' perspective on the impact of COSEE on their teaching is related to their personal and professional characteristics.
7. Respondents note other personal and institutional benefits from COSEE.
8. Respondents are reaching out to underrepresented audiences, but institutions are still finding it challenging to recruit them into the sciences.

The survey results contribute to understanding the benefits of the Network to scientists and the scientific enterprise and provides evidence and support for NSF's investments in education and outreach. The results also underscore that sustained duration of engagement is needed in order to witness the types of transformative outcomes observed among the survey respondents. It suggests that substantial investment is required to meet NSF's goals for Broader Impacts and to transform relationships between scientists and educators.

IV. Challenges

There are challenges to achieving effective broader impacts activities. This section will address several of the challenges expressed by ocean researchers and how COSEE has worked to provide solutions to these challenges.

A. Time

As mentioned, the time, money and effort to invest in improving broader impacts activities is a major obstacle. The COSEE Network addressed this issue by preparing ocean scientists and engineers in a number of ways. Models used currently include:

- the lunchbox model – taking a researcher to lunch or some other informal setting to share ideas and engage their interest;
- coordinating preparation efforts with academic departmental events (e.g., seminars)
- the webinar model – online preparation that is scalable, but maybe not the best initial approach since personal touch is important initially
- the peer-to-peer training model – leveraging ocean researchers who have already demonstrated an interest and aptitude for broader impact activities to be involved in assisting others
- face-to-face training and provision of practical tools (e.g., resources on how to tell an effective story).

B. Transferring Expertise and Resources to Classroom and Public Audiences

The transference of scientific content and understanding to the intended audiences is an important goal for education and outreach programs. COSEE is achieving this in a number of ways. The following strategies are currently being implemented across the Network:

- Briefing papers are written by scientists and engineers that are concise, accessible and easy to share with decision makers, media, etc.
- A wide variety of supporting content resources are being produced and delivered using communications technology, including via online, through different types of media, over Skype, through YouTube, Facebook, Twitter, blogging, etc.
- Informal science exhibits are developed including casual, informal table-top devices and games.
- Curriculum is being co-developed by scientists and teachers.

C. Diversity

The ocean sciences present a challenge for increasing diversity. The biggest obstacle is (based on NSF data), that over the last decade, less than 6% of the graduating Ph.D.s in ocean sciences are from groups underrepresented in science, engineering, and technology disciplines.

There is a substantial body of literature that examines effective ways of reaching racially or culturally different groups. The COSEE community has focused on building its familiarity with these strategies and providing professional development opportunities for scientists on effective engagement strategies for underrepresented groups. Centers have the ability to reach these groups through partnerships with school districts and undergraduate populations at partner institutions.

Scientists are prepared to work with diverse audiences by several Centers. COSEE West and COSEE Pacific Partnerships use K-12 teachers to help scientists understand the challenges. COSEE Ocean Learning Community (OLC) has initiated a program for

minority high school students from local school districts. The students participate in research where they are able to choose their own research questions and present their results. OLC has also provided cultural sensitivity training to their GK-12 graduate students who are placed in highly diverse schools. These graduate students also created a science curriculum designed for social justice.

V. Conclusion

Centers and Center evaluators over the past decade have collected evidence indicating that COSEE has successfully served the ocean sciences research community, educators, and the public through three channels:

- Understanding researchers' needs and issues related to the fulfillment of broader impacts for research proposals
- Developing researchers' communication and pedagogical skills, understanding of audience needs, education culture, and educators' needs so that they can more effectively implement broader impacts activities
- Connecting ocean scientists and engineers with educators and public audiences in ways that have transformed ocean sciences education

COSEE's support for scientists can be categorized into these sectors: 1) professional development in support of engaging in education, outreach, and communication; 2) tools for use with, or support for, education, outreach, and communication; 3) information, consultation, and advice for expanding broader impacts; and 4) establishing collaborations and productive partnerships in furtherance of a broader impacts mandate.

Each of these services has taken multiple forms supporting one or more of the following types of activities: grant writing; education, outreach, and communication activities; broader impact requirements development and implementation; cultivating collaborations between and among individuals and organizations; working with teachers (K-16); engagement with the public; and scientists' professional development focused on teaching and learning.

The vision of the National Science Foundation to establish a robust national Network which engages ocean scientists in education, outreach, and communications activities has been realized. The National COSEE Network has developed and demonstrated successful models for scientist engagement in broader impact activities. It is poised to continue supporting the ocean science enterprise and assisting researchers with inspiring the next generation of ocean researchers and enhancing public ocean literacy.

VI. Acknowledgment

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