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Communicating Ocean Sciences to Informal Audiences: A Scientist-Educator Partnership to Prepare the Next Generation of Scientists

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Communicating Ocean Sciences to Informal Audiences (COSIA) is a college course that creates and develops partnerships between science educators in informal science education institutions, such as museums, science centers and aquariums, and ocean scientists in colleges and universities. For the course, a scientist and educator team-teach inquiry-based science pedagogy and communication strategies to graduate and undergraduate students in marine science-related majors. In addition, students participate in practicum experiences in informal science education institutions. COSIA aims to engage the next generation of scientists (college students) in learning to communicate their scientific knowledge with the general public. This paper describes how this course and the resulting partnership address some major issues in scientific literacy, as well as how they benefit all the stakeholders (scientists, science educators, college students, and visitors to informal science institutions). Three central challenges to creating partnerships and how they were addressed are outlined, and several underlying principles for initiating and growing partnerships between individuals and institutions are presented. Through the process of engagement in this effort and the development of partnerships between educators' and scientists' communities of practice, it is argued that a new hybrid community of practice may be emerging.

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RATIONALE AND SIGNIFICANCE

Communicating Ocean Sciences to Informal Audiences (COSIA) is a college course that creates and develops partnerships between educators in informal science education institutions (ISEIs) and ocean scientists in institutions of higher education (IHEs). COSIA prepares them to teach inquiry-based science pedagogy to undergraduate and graduate students in ocean sciences-related majors. The course aims to engage the next generation of scientists in learning to communicate their (ocean) scientific knowledge with the general public in informal environments. The course, and the partnership that develops, addresses two major issues in scientific literacy in general, and in ocean sciences literacy in particular. First, the course addresses the increasingly urgent need for scientists to engage and communicate more effectively with the public about scientific issues (Leshner, 2007; Lubchenco, 1998). The course immerses university science students in discussions and practical experiences about how to communicate their knowledge of ocean sciences with the public who visit ISEIs such as aquariums, museums, and science centers. Informal environments are valued as places where people come to learn, play, talk, and explore science (National Research Council, 2009). As significant cultural institutions, ISEIs are used in this course as training grounds for young scientists to learn to communicate about science with the community. In turn, the general public has the opportunity to interact directly with the next generation of scientists. Second, the course focuses on ocean sciences in particular because the ocean is consistently overlooked in K-12 education (Hoffman and Barstow, 2007; McManus, et al., 2000). As a result, the public has a low level of knowledge and awareness of the concepts and issues pertaining to ocean ecosystems, ocean-atmosphere interrelationships, and the connections between the ocean and human beings and their activities (Steel et al., 2005; The Ocean Project, 2009).

The partnership between an informal science educator and a scientist is important; as it creates a way for both to work together to support scientific literacy that builds a prolonged and mutually respectful relationship. Collaborations between scientists and educators have been emerging as mechanisms for science education reform over the last two decades. Such work includes, but is not limited to, the following: scientists providing professional development programs for teachers (National Research Council, 1996); graduate science students teaching lessons in K-12 classrooms (Busch and Tanner, 2006); scientists offering their content knowledge to assist in the development of curriculum and instructional materials (Linn, 1995). In most of these instances, the scientists provide subject-matter expertise, which the educators then use to ensure the scientific accuracy and credibility of their pedagogical activities.

In the partnership between Lawrence Hall of Science and UC Berkeley, scientists and informal educators go beyond these typical roles, as both contribute their expertise to the content material of the course. COSIA uses ocean and climate

sciences as the subject matter to introduce undergraduate and graduate student scientists to inquiry-based science pedagogy; it is co-taught by an ocean scientist from a university or college and a science educator from an informal environment. The students learn about teaching ocean sciences in informal environments and apply their understanding in a six-week practicum (approximately two-three hours per week) where they facilitate hands-on activities in the informal setting. For scientists, teaching the course not only draws on their expert knowledge of ocean and climate sciences, but also encourages them to think about how they communicate and teach this content in relation to their beliefs about how people learn. It builds their capacity to use current research-based pedagogy to better communicate science to the public and to apply the pedagogy embedded in the course broadly to all of their teaching. For informal educators, teaching the course not only uses their expert knowledge of learning and teaching in informal environments, but also requires them to articulate their pedagogical content knowledge. In addition, it builds their capacity to observe and assess effective science pedagogy and to apply the knowledge to their practice.

As members in these two distinct communities of practice engage in collaborative partnerships, they cross into and out of the boundaries of each other's communities; over time and continued commitment, they may create a new community in which to meet and work together. A community of practice is a group of people with shared customs and habits. It is characterized by the following: (1) *joint enterprise* towards common goals and purposes*;* (2) *mutual engagement* in activities; (3) development of a *shared repertoire* of habits, rules, and traditions; and (4) the process of *negotiating meaning in practice* (Wenger, 1998). Boundaries are constituted by normative practices, rules, and roles that are embedded in distinct communities of practice, which both facilitate and constrain learning. We argue that in the process of crossing boundaries into and out of one another's communities of practice, scientists and educators teaching this course are creating a new community where members inform and develop their professional knowledge and sustain their relationship beyond the course.

In committing to the partnership for the course, there was *joint enterprise* between ocean scientists and informal educators towards the goals and purposes of achieving an ocean-literate population through informal educational experiences. There was *mutual engagement* in team-teaching the course. And in doing so, the scientists and educators also engaged in collective learning about each other's valued practices, tools, guiding principles, and goals and then developed a *shared repertoire* of habits, rules, and traditions for their new community. Members were *negotiating meaning in practice* as they met to plan, teach, and assess the class sessions throughout the semester. Crossing boundaries between communities of practice "exposes our experience to different forms of engagement, different enterprises with different definitions of what matters, and different repertoires—where even elements that have the same form belong to different histories" (Wenger,

1998, p. 140). Since participants enter into new and unknown domains that challenge their claims to expertise, boundary crossing calls for a reconceptualization of mastery: a shift from viewing knowledge as distributed hierarchically among people who possess different levels of skill and competency to "knowledge as distributed across actors who are competent in different types of practices, and with whom individuals must negotiate the use of multiple tools and patterns of interaction" (Anagnostopoulos, Brass, and Subedi, 2007, p. 102).

ABOUT THE COURSE

The Communicating Ocean Sciences series

The course upon which this new community of practice was built is one of two versions in the Communicating Ocean Sciences (COS) series that was created at the Lawrence Hall of Science (LHS), the public science center of the University of California at Berkeley. The primary difference between the two courses, COS K-12 and COSIA, is where the students in each do their practicum (in K-12 classrooms or informal environments, resp.). COS K-12 was first developed with funding from the National Science Foundation Geosciences Directorate, Division of Ocean Sciences (Grants no. OCE-0215500 and no. OCE-0731182) for the Centers for Ocean Sciences Education Excellence-California (COSEE California) at the University of California, Berkeley. The course was successfully taught, documented, field-tested, evaluated, and shared through the National COSEE Network and beyond. LHS leveraged its work on the COS K-12 course to obtain funding in 2006 from NSF's Informal Science Education (ISE) division to create and field-test COSIA (Grant no. ESI-0540417). The COS K-12 course materials and practicum were revised for COSIA to reflect the affordances and constraints for learning science in informal environments. Both courses are currently taught in over 20 universities nationwide.

The Communicating Ocean Sciences series brings together ocean and climate scientists in colleges and universities with master educators in formal (COS K-12) and informal environments (COSIA) to work towards the following goals: (1) to improve the ability of science faculty to communicate science concepts and research to their undergraduate students; (2) to provide both science faculty and college science majors with direct experience using exemplary, research-based, well-evaluated instructional materials that illuminate best practices in science teaching and learning theory; (3) to place diverse future scientists (undergraduates) in a substantive outreach practicum where they are introduced to the importance of education, outreach, and the broader impact of ocean sciences research, as well as to possible careers in science education; (4) to promote thoughtful, mutually beneficial collaborations between ocean scientists and educators co-teaching the course; (5) to provide significant ocean sciences instruction and college role models

for both K-12 students from underrepresented populations and visitors to ISEIs, as undergraduates participate in the outreach (practicum) portion of the courses.

In brief, the Communicating Ocean Sciences courses incorporate the pedagogy and learning theory described in works such as *How People Learn* (Bransford et al., 2000), *Taking Science to School* (National Research Council, 2007), *Understanding by Design* (Wiggins and McTighe, 2005), and *Designing Professional Development for Teachers of Science and Mathematics* (Loucks-Horsley et al., 2003). Each class session includes opportunities to (1) experience, discuss, and grapple with ideas and concepts through active adult learning experiences that push students to think deeply about ocean sciences concepts and science education pedagogy; (2) learn what research says about how people learn and about pedagogical topics such as constructivism, questioning strategies, or responding and discussion strategies; (3) participate in activity exemplars they can use in their field practicum that illustrate science concepts and pedagogies introduced in the session; (4) reflect on their own learning, now and in the future. Practical experiences are a critical component of both courses. Students are required to present six lessons in a K-12 classroom or at an ISEI, during six two-hour sessions over a minimum of six weeks. As the students teach learners about ocean science, they first use previously developed, well-tested exemplar lessons and activities and later use a lesson or activity that they themselves designed during the course. For complete information about the courses, including all course materials, descriptions of professional development, and where they are being taught, please visit the COSEE California Web site: http://www.coseeca.net/programs/communicatingoceansciences. Exemplar COSIA Activities used in the course can also be accessed as part of the NSF and National Science Digital Library (NSDL) SMILE Pathway at http://howtosmile.org.

COSIA and the COSIA Network

Six partnerships were originally created to field-test COSIA. They were three-way partnerships between the LHS and an ISEI partnered with their local IHE. On one level, the partnership was a commitment and collaboration between individual educators and scientists. On the other level, it was a trusting relationship between their two institutions. In this instance, the course was offered at the university and eventually institutionalized as a permanent class; in some cases, it became a part of departmental requirements. As a major part of the course requirement, students did their practicum at the ISEI, where they directly interacted with the public and thus were viewed by visitors as representatives of ISEI.

The initial partnering institutions included the following:

- Hampton University and Virginia Aquarium and Marine Science Center
- Oregon State University and Hatfield Marine Science Visitors Center
- Rutgers University and Liberty Science Center

- University of California, Berkeley and Lawrence Hall of Science
- University of Southern California and Aquarium of the Pacific
- University of California, San Diego (Scripps Institution of Oceanography) and Birch Aquarium at Scripps

The range of institutions finding success with the course demonstrated the flexibility of the model and the universality of the needs it addressed. Approximately 1,200 undergraduates and graduate students have now taken the COSIA course, and student scientists have taught ocean sciences to over 30,000 children and families visiting ISEIs.

To further support this successful partnership model, NSF ISE funded the COSIA Network (no. DRL-0917614) in 2009, thus allowing COSIA Network scientists and educators to continue to work with one another, and thereby strengthen the community of practice that they created. Additionally, these original partners take on leadership and creative roles to expand the community and devise new shared goals and materials. First, these original Network partners serve as regional support and dissemination hubs for the scientists and science educators teaching the course in their area of the country, thereby expanding the community of practice beyond the original partners. Second, original Network scientists and educators are working together to revise the course material and draw on the strengths and uniqueness of their individual partnerships to create a variety of professional development workshops to help informal educators and research scientists improve their communication skills.

The professional development materials and workshops used to prepare instructors, the course curriculum, and the outreach materials used by students have all been the subject of a robust evaluation effort that has documented their effectiveness—both for achieving the goals as stated above and also for supporting and encouraging successful boundary crossing. A full technical final evaluation report by Inverness Research the external evaluators of the project (St. John & Phillips, 2010), which includes three case studies, is available at http://www.inverness-research.org/abstracts/ab2010-06_Rpt-COSIA-final-eval-rpt.html

Ocean Sciences at LHS

The Communicating Ocean Sciences series fits well with the long-term commitments at LHS to ocean science literacy, in terms of both curriculum development and professional development (for more about LHS see http://www.lawrencehallofscience.org/). For decades, LHS has offered MARE (Marine Activities, Resources & Education), a whole-school interdisciplinary ocean science immersion program that provides professional development for teachers, curricular materials for schools, and resources for families (for more about MARE see http://www.lawrencehallofscience.org/mare/). LHS, through MARE in partnership with Scripps Institution of Oceanography and the College

of Exploration, also serves as one of twelve existing National COSEE centers (http://www.cosee.net/) and has taken a leadership role in the Ocean Literacy campaign, which developed both Ocean Literacy: The Essential Principles for Ocean Sciences K-12 and the Ocean Literacy Scope and Sequence (http://www.oceanliteracy.org/).

CHALLENGES AND SOLUTIONS

To create and support successful partnerships required for the COSIA course and to encourage potential partners to recognize the value of what the partnership could bring, we were faced with three central challenges: (1) providing potential partners with a reason to work together and the tools and infrastructure to help them be successful; (2) helping partners negotiate their individual system and work towards gaining support to institutionalize the partnership and create new and ongoing opportunities to work together; (3) helping scientists to overcome the hurdles they encounter when attempting to engage in education and public outreach. Here, we share examples of these challenges in our case and how they were addressed.

Providing Tools and Infrastructure

For the partnerships to be successful, it was necessary for members of the community to have shared activities around which they could do meaningful work together, where each member of the community felt empowered to share the expertise he or she had. The course and materials served this purpose. As described in the final evaluation report from Inverness Research, one aquarium director explained the importance of the course as follows:

> When we partnered with other universities before, we would have a meeting and come up with great ideas that never went anywhere. But the COSIA course structured those partnerships so that we could actually be successful. Maybe it is because there is money involved, but there was a deliverable, there was an outcome, there was a beginning, a middle, and an end and so that I think was a really good part of it (St. John & Phillips, 2010).

Another aquarium partner described how the course provided a structure that individuals could easily work within as follows:

> We would love it at the aquarium to have scientists from the university coming to talk about their science, but I do not think that it would happen if we just said, 'hey scientists, come talk. With COSIA, there is a course and there are credits and they can fit themselves into that structure' (St. John & Phillips, 2010).

University scientists also saw the importance of the structure in the successful implementation, as described by one, who said, "I know why I am involved and why research scientists are involved is because COSIA is structured in a way that is very easy for us to participate" (St. John, Phillips, Smith, & Castori, 2009).

In an interim report, St. John and Phillips (2009) from Inverness Research, explained why it was important for members to able to share their expertise while they worked together on a concrete task:

> The course holds the partnerships together and promotes cross-disciplinary discussion and knowledge building between the scientists and the ISEI educators. By design, individual partners must work together to think about how they are going to assess students, and how they are going to structure and describe the course. These processes get partners thinking differently about their own worlds and each other's world.

Thus, both scientists and educators were encouraged and challenged to contribute their experiences and expertise as they taught the course together. (For the complete interim report from Inverness Research, please see http://www.inverness-research.org/abstracts/ab2008-12_Rpt-COSIA-interim-eval-rpt.html)

Negotiating Institutional Support

Establishing shared work as a norm in the organization was necessary for the partnerships to be successful, as it ensured that the relationship could be sustained beyond initial trial periods. We learned that the partnership first required departmental support at the IHE and institutional buy-in at the ISEI, which were not easy to obtain. Many universities and colleges were under extreme economic constraints, and thus had a difficult time adding new courses to their curriculum. Providing initial grant funding to the IHEs helped defray initial costs of planning and implementing the course. Many IHEs first offered the course on an experimental basis. As the course became known and acknowledged by the faculty and student body, the scientist partners filed the necessary paperwork to make it a permanent course, which meant that they and their colleagues could teach it as part of their regular teaching load, with compensation provided by the IHE. In many cases, the process of institutionalizing the course included additional obstacles, such as needing to obtain the approval of faculty sponsors, departments, and/or committees. To further assist faculty scientists in introducing and then institutionalizing the course, we provided course descriptions and other relevant materials that could be easily modified and used to complete the paperwork required to offer the course at individual sites. Despite these hurdles, at over half of the universities where the course was taught, the university provided funding to make it available on an ongoing basis and has also allowed tenured faculty to teach it, thus moving it past its experimental status.

For the course and partnership to be institutionalized by both the IHE and ISEI, they needed more than quality material and relentless support from the LHS team; they also had to be of interest and value to those they served—the university science students. Fortunately, students found the experience tremendously meaningful and were willing to share this opinion with their friends. In 2008, over 90% of the institutions reported that students were spreading the word about the course among their classmates. The importance of such recommendations was summarized by one faculty member who said, "as students talk about the class, they slowly change the culture of the department." Other faculty scientists also viewed the course and the partnership positively, as the next two statements from the COSIA Final Evaluation Report (Randol, 2010) attest:

> COSIA is changing the professional practice of the faculty in our building. They are coming and asking for help in modifying their teaching of 100- and 200-level classes. I think this is exciting and ultimately what a course like COSIA can/should do.
>
> ***
>
> I will likely be teaching a course very similar to this on a regular basis to our grad students. It may eventually become part of the core curriculum for grad students.
>
> ***
>
> We invited the Associate Director of undergraduate programs to come sit in on one of our classes and she saw our students doing their activities on the floor and I think that was a good thing for her to see. Some of her [grad] students were in the class too. I think she has a better understanding of what the class is about now and got involved in this conversation of how we can take it to the next step. So we are slowly getting there … we are moving in that direction (St. John, 2010).

Overcoming External Hurdles

The success of the partnerships was dependent upon individual partners being free of external conditions that prevented them from fully participating and contributing to the partnership. For the faculty, who are research scientists, these external conditions included the challenge of taking time away from doing research; competing priorities; lack of knowledge of opportunities; lack of access to coordinated and structured efforts; the low value their institution placed on outreach efforts (Andrews et al., Weaver, Hanley, Shamatha, & Melton, 2005). For many Tier 1 research institutions, education and public outreach may not be highly valued

or considered to be relevant factors in helping tenure-track faculty achieve professional advancement. This lack of recognition and rewards in the tenure process, and the fact of faculty advising their graduate students that their research must come first since there are so many things they must do in order to prepare for a career in the field, sometimes led to a lack of support for the partnership from advisors and departments.

Fortunately, COSIA has played a significant role in overcoming some of the obstacles that scientists and their graduate students face in participating in outreach. University scientists have described how COSIA is actually helping them be more successful in recruiting graduate students, sharing their research with the public and gaining prestige in the science community—including receiving accolades from their university—through acquiring research funding, in part based on their inclusion of the course in their proposals as part of their broader impact efforts. One university researcher described how the COSIA course helped scientists achieve their goals:

> Scientists do need to communicate. Why are they interested? They are interested in the things that help their research. They are very much interested in how do they get funding, how do they find students, how do they continue exploring, and how do they continue learning? We also want to get students and so how do we increase that pool of students? We are concerned about the pipeline (St. John & Phillips, 2010).

And another university scientist commented:

> Even if you are going to be involved with research, it is appreciated that outreach is going to become an important part of it. Everybody has to be comfortable with the fact that outreach is being done or they will have to work with someone who is doing some kind of outreach. So, to me, COSIA represents a unique resource on campus and something that is not central to our goal, but is indeed an important resource. It is an important resource to us because not only it is unique, but also it is, in my view, stellar (St. John & Phillips, 2010).

The partnership in the COSIA course helped IHEs to achieve their outreach mission on a large scale. Faculty teaching undergraduates and graduate students had the opportunity to work with master educators to prepare dozens of students to do effective outreach or to create a broader impact effort for their entire lab; as a result, they did not have to attempt to do outreach just by themselves. The course helped overcome the time constraint issue from two vantage points as follows: (1) the structure to engage the students was already in place, and the informal educators monitored, mentored, and placed the students in informal environments so that the

scientists did not have to coordinate or design the efforts themselves; (2) instead of just one individual providing outreach, the entire class of students or an entire university scientist's lab undertook the endeavor.

THOUGHTS FROM SCIENTISTS, EDUCATORS, AND STUDENTS

The partnership and course has been a significant experience for the scientists, science educators, and science students involved. The ocean scientists reported that the course provided them with a heightened awareness and practical knowledge of learning theory and appropriate pedagogy—which typically fell within the domain of the educators' practice—and that they became more effective educators and communicators of science as a result. This revelation had implications for their work with future students, fellow scientists, and the general public. For instance, one scientist commented, "As a scientist, we are not trained as teachers. There are a lot of techniques that I learned that were helpful. Thinking about audience while preparing presentations will change my teaching. I modified things I was teaching in other classes in real time" (St. John & Phillips, 2010). Scientists also reported that the partnership and course prompted them to think differently about the normative practices of the science community, and actually changed their work within their own community. Another scientist said, "I think the biggest benefit to [the scientist] is that a lot of times they are taught how to become a scientist but lose touch with how to present that science" (St. John & Phillips, 2010). Thus, this partnership provided scientists with expanding opportunities for outreach work. This sentiment was reflected in the following comment: "We really need to be able to communicate well why our research is important, and it is not formally trained … we need it to teach in the future, for outreach events, grant proposals, and in order to summarize what we do" (St. John & Phillips, 2010). The boundary crossing that scientists experienced in teaching the course also allowed them to cultivate a network of contacts and resources within the education community of practice, focused on the practical application of ocean sciences research and content.

The informal educators were introduced to some of the knowledge, rules, and norms of the scientific community, while also being given the opportunity to reflect on and change their typical practice within their own community. The partnership for the course provided informal educators with a heightened awareness and practical knowledge of current scientific research and increased their opportunities to enhance the rigor of the science content in the programs they offered for a wide range of ages. One aquarium director reported seeing

> a very enlightened, interesting, and significant shift in the way educators think about knowing and learning and consequently how to engage the public in understanding science. This is significant. These institutions have grown up historically as houses of artifacts

> and factual information … but now they can promote a true deeper component of science learning (St. John, 2010).

Furthermore, the work and expertise of the educator community of practice were made more visible and relevant in the eyes of their colleagues and in their perceptions of themselves. As one educator said, "Integrating into the [science] community in a way in which we have never done before is huge and it allows us to demonstrate our professional expertise and prowess. Professionally, we are recognized differently in our peers' eyes" (St. John, 2010).

The college students echoed these same sentiments; one said, "I think it is a great course and should be incorporated into the course requirements of research programs. When you are pursuing research, it is easy to forget how important it is to be able to communicate your science to a broader audience" (Randol, 2010). All students who have taken the course reported that the course influenced how they thought about learning, while 98% acknowledged that the course influenced how they thought about teaching. Over half (58%) reported that taking the COSIA course resulted in them engaging in, or planning to pursue, other experiences in education or communication (e.g., internships, part-time jobs, summer jobs, and other related courses). Students showed significant changes in their attitudes and knowledge about teaching and learning, an increased familiarity with educational concepts, and improved levels of comfort, preparedness, and enjoyment with topics such as teaching science and public speaking. One student said, "This was a great course that I would recommend all graduate students take at some point during their education. This was a very positive experience and the most applicable and useful class that I have taken to date" (Randol, 2010). And a university scientist reported, "The students say they were learning to refine complex scientific concepts and communicate the important points to the broader public. The benefit they speak of mostly is the confidence building experience of being introduced to the theory and then applying it in a safe environment. The course is like no other course they take in their career" (Randol, 2007).

LESSONS LEARNED, CONCLUDING THOUGHTS

From our experience of negotiating and coordinating partnerships for the Communicating Ocean Sciences series, and for COSIA in particular, we learned several underlying principles for initiating and growing partnerships between individuals and institutions in different communities of practice. In brief, these include the need to the following:

(1) Draw on existing relationships and connections and ask colleagues to in turn contact other colleagues to join in the effort as well. It is helpful to select partners who have shared values, goals, and/or ideologies.

(2) Think of knowledge and tools as assets to be shared that can be built on and revised by the community. Encourage ownership of these assets among all the members of the community.

(3) Cultivate mutual respect by encouraging a culture of honesty, open dialog, careful listening, and by recognizing distributed expertise.

(4) Define goals and processes clearly and, very importantly, have a shared activity around which all partners can do meaningful work together to achieve those goals.

Successful application of these principles is reflected in long-lasting partnerships that extend beyond any one project, as members strive to work together and sustain the new community. This success is evidenced by continued collaborations between the scientist and educators, as indicated by the following statement:

> [We] have had the benefit of co-teaching [COSIA] for the past 3 years. That consistency has allowed us to get to know each other's strengths and areas of expertise, which makes the overall teaching experience a positive one. It is truly a partnership when we teach this class … COSIA … has been a catalyst for initiating additional partnerships between the two institutions. Staff and students in [the IHEs] marine science department serve as mentors in the [ISEIs] Mentoring Young Scientists (MYSs) enrichment program for middle school students, while [ISEI] educators provide activities for the [IHEs] High School Open House Day (St. John & Phillips, 2010).

These partners are pursuing funds elsewhere to continue working together on other projects. Thus, there are ripple effects emerging from these personal connections that take on a life of their own and create momentum as scientists and educators communicate, collaborate, and learn from each other.

> There has been historically a separation between education and scientific research and I see this course as a great bridge – one that prepares future scientists and educators with a connection before they hit the streets, if you will. I think that is one of the crucial things with this course. And when we are talking about broader impact, if you are putting these students that take the course into these informal science institutes, the general public is getting a more enriched experience as well – and a very current experience. I think that is a huge, huge area that needs to be addressed and is addressed with a course like this.

Moreover, we are having a significant impact on the way current and future scientists think about teaching and learning. In many cases, current scientists are actually changing the way they teach their courses to reflect current research and best practices in learning and teaching that are addressed in COSIA. Meanwhile, future

scientists reflect upon how they learn in their university classes and consider how they might want to teach and communicate their science knowledge in their future careers. It is the success of the partnership between the scientist and educator who are team -teaching the course that makes these outcomes possible.

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