i. Project Rationale

This Pathways project will determine and communicate how the Research Vessel \textit{JOIDES Resolution} and scientific research vessels around the world can work with informal science providers to address the program solicitation’s calls to: (1) enhance STEM learning for people of all ages, (2) integrate “cutting-edge STEM content and the engagement of scientists, engineers, and educators from the range of disciplines represented at NSF,” and (3) demonstrate “innovation in anywhere, anytime, lifelong learning.”

\textit{Ship to Shore Science} will convene a group of informal programming experts, scientists, and programming end-users to assess how best to use the education assets of the \textit{JOIDES Resolution} (the \textit{JR}) and Deep Earth Academy (DEA) to capture the attention of selected family, museum, student, scout, online, radio, high tech and/or television audiences. Through the use of an Open Space technology meeting, the group will conduct a front-end needs assessment and gap analysis, then select and pilot content and methods that erase existing barriers between informal audiences and this world class research ship for increased awareness and understanding of the nature of science, fundamental Earth and ocean science principles, and careers in science, technology, engineering and math (STEM).

The goals of this project are to:

• Refine and select the very best methods for sharing the excitement of the \textit{JR’s transformative and cutting-edge science, the nature of science and STEM careers with shore-based informal audiences}
• Develop prototypes and partnerships to showcase, assess and share these methods
• Disseminate awareness and knowledge of \textit{JR-based science, which is key to our understanding of fundamental Earth processes, throughout the U.S.}

\textbf{Setting the Stage:} “At 1630, a voice breaks through the drone of the thrusters to announce the sighting of an Ocean Sunfish (\textit{Mola mola}) off the port amidships. All the scientists, teachers and illustrators who can leave their work do so, grabbing sweaters and cameras on their way outdoors. It is one of many moments of excitement shared by this seemingly odd blend of more than 100 individuals with varied skills and talents that, after ten days at sea, is becoming a team. The ship’s manifest reveals they left family and friends in 12 countries. They will sail together without making port for 59 days. Their mission aboard the world-class \textit{JOIDES Resolution} is focused on the hydrogeology of the ocean’s crust, and includes the stuff of science fiction – giant observatories in the seafloor packed with instruments capable of measuring temperature and pressure 675 meters below (Fisher, et al, 2010), ingenious osmosamplers that employ the basic principles first learned in high school chemistry to sample water in the crust for years to come, and substrates specially made to attract unknown microbes of the deep, dark biosphere. This is Integrated Ocean Drilling Program Expedition 327, Juan de Fuca Hydrogeology. This is the ship and these are the people who can best interpret Earth science in the making – live from anywhere in any ocean.”

-- \textit{An Expedition 327 Education Officer, July 2010}

\textbf{A Platform for Science:} From the longevity of the ship’s dedicated crew and staff (many have served more than two decades) to her ten different laboratories and incredible 20-year legacy of scientific discovery, the \textit{JR} is the ultimate science factory. Her seven-story “lab stack” is loaded with state of the art
scientific instruments that enable researchers across the globe to tease Earth’s secrets from pristine seafloor samples, the cores that are retrieved onto the deck and fill her labs around the clock. To thousands of scientists on hundreds of expeditions, this ship is a tool for research staffed by the best technicians in the world. For her drillers and crew, the JR and her mission represent an unparalleled challenge, with ever changing worldwide objectives in all types of formations and waters as deep as 9,000 meters. But for educators, the JR is magic; a 143-meter, sea-going student magnet and hook for learning brimming with real science, real discoveries, real technology, and 120 fascinating people with colorful lives and careers.

A Platform for Education: In his 2009 speech to the National Academies of Science, President Obama urged his audience to “spend time in the classroom, talking and showing young people what it is that your work can mean, and what it means to you” (White House, 2009). And that is exactly what this program is doing from aboard the JR. DEA is using this wondrous vessel as a platform for education as well as science. Beginning with Expedition 320 in March of 2009, the first outing since a massive two-year renovation, and for all scheduled expeditions to come, DEA coordinates education programs originating from every part of the JR, from the core tech shop to the labs and Bridge; including scientists, technicians, and ship’s personnel from every sector of the operation.

DEA is bringing classrooms and museums onboard through real-time and asynchronous, value-added, expedition-based education programs via ship-to-shore video broadcasts and Web 2.0 communication tools linked to the ship’s public website (www.joidesresolution.org); a site filled with scientists’ blogs, games, and videos for all ages that highlights the wonder of discovery through work and life at sea. Originally designed to target middle school students and family audiences, the site and its associated social media (YouTube, TeacherTube, Flickr, Twitter, and Facebook) have a growing audience that includes university-level students and adults (Figures 1 and 2). New approaches like the graphic novel Tales of the Resolution (Appendix 1) and weekly video updates are being added to the website as quickly as fresh ideas can be formulated.

Figure 1. JR website growth: Unique visitors +42.11% in 2010 over 2009. (Google Analytics)

Figure 2. JR Facebook fans by gender and age
To manage its expedition-based education programs, DEA matches expedition scientists and science objectives with Onboard Education Officers (teachers and informal science professionals) and programming partners selected to engage specific audiences or regions. To date, 100 live video broadcasts and webinars have been presented by 10 sailing educators and countless volunteer scientists to nearly 13,000 teachers, families, and students at schools, museums, and special events across the United States, Mexico, Japan, India, Australia, France, Scotland, Great Britain, New Caledonia, Spain, and the Netherlands. Webinar partners have included U.S. Satellite Laboratory’s NSF-funded SPRINTT (http://us-satellite.net/antarcticalive/), the Global Nomads Group (http://www.gng.org/product/videos/videoconference_archives_2009.html) and the Texas Education Telecommunications Network (http://www.tetnplus.net/event_details.aspx?eventID=223). In addition to these activities, DEA distributes ship and expedition-based learning materials at no cost to users, including JR tracking maps, monthly newsletters, models, videos, hands-on activities for early learners, and intensive data-rich materials for college level students developed by faculty and teachers who have sailed as a part of its highly-competitive School of Rock Expeditions for Earth and Ocean Science Educators (Leckie, 2006; St. John, et al, 2010).

**The Mandate:** In 1990, The American Academy for the Advancement of Science’s (AAAS) Project 2061 (Rutherford and Ahlgren, 1990) put forth the importance of science education in sustaining the country’s economic vitality and security, and provided recommendations for basic Earth science knowledge as a means of understanding our physical environment. Fifteen years later, the National Academy of Science report “Rising Above the Gathering Storm” (National Academies Press, 2007) warned that without improved federal support for science and technology research and education, the country may lose its competitive edge and suffer an eroded quality of life. These and other reports (AAAS, 1993 and National Research Council, 1996) raise awareness that the U.S. science community needs to leverage its collective resources in creative and innovative ways to communicate the relevancy of science to the country’s youth and the broader population.

Throughout its history, the National Science Foundation’s (NSF) mission has included the integration of research with education, an investment priority in its current strategic plan. The plan also prioritizes informal education as a means of engaging and informing the public in science and engineering (NSF, 2006); and the National Science Board (2007) describes informal education as an essential means of increasing awareness, learning, and interest in science, technology, engineering, and mathematics (STEM). Federal funding agencies, and NSF in particular, has challenged science programs and researchers with a fundamental question: How can you and how do you broaden the impact of your research? Our answer is to investigate every possible means of erasing the boundaries between our shipboard science program and learners in informal settings – making Earth systems science accessible through real-time, hands-on experiences in the high-powered and truly authentic setting of the JR linked live to museums, libraries, and living rooms across the United States.

**The Need:** As an NSF funded facility, DEA – the education division for the Integrated Ocean Drilling Program’s (IODP) United States Implementing Organization (USIO) and United States Science Support Program (USSSP) – has a responsibility to design and facilitate public education activities that showcase U.S. scientists and ship’s personnel in their lives and work aboard the JR (IWG, 2001).

<table>
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<th>About IODP</th>
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<td>The Integrated Ocean Drilling Program (iodp.org) is an international research program dedicated to advancing scientific understanding of the Earth through drilling, coring, and monitoring the subsea floor. The JOIDES Resolution (JR) is one of the largest research vessels in the world; it is managed by the U.S. Implementing Organization of IODP (USIO). In this last year alone, the JR has drilled 932 cores, recovering over 4479 meters of sediments.</td>
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With the launch of each new program, from the School of Rock Expedition for Earth and Ocean Science Educators in 2005 to joidesresolution.org and live ship-to-shore video broadcasts in 2009, requests for materials and applications for programs continue to grow at a rate of at least 25 to 35% per year (USIO, 2009). Demand and interest seem clear, however DEA is consistently working at or beyond its capacity. What more can we do to leverage the JR and DEA’s education assets (Table 1) given the ship rarely
makes call in U.S. ports? We have a significant number of models and tested programs, but how can we bring more students and families aboard to meet the scientists and participate in science at sea? What is the best contribution we can make to the national mandates for improved STEM education and scientific literacy? How can we employ informal education principles and partnerships to improve and expand our programs? These are the fundamental questions at the heart of Ship to Shore Science.

IODP AND DEEP EARTH ACADEMY SCIENCE AND EDUCATION ASSETS

- R/V JOIDES Resolution sailing four or more two-month expeditions per year: scientists from 24 member nations representing many scientific disciplines
- Shipboard physical properties, chemistry, paleomagnetism, microbiology, sedimentology, micropaleontology, and X-ray diffraction laboratories, among others
- Ship-based video broadcasting equipment and bandwidth sufficient for programming
- Onboard Education Officers facilitating ship-based education programs on every expedition
- JOIDES Resolution website (http://joidesresolution.org/) for student and family audiences
- Gulf Coast Repository with lab and meeting spaces for up to 30 participants
- Core, sediment, rock samples and drilling artifacts
- Google Earth drill site map linked to expedition data
- ANDRILL’s Coreref.org web-based access to IODP and other core photos and data
- Columbia University’s GeoMapApp.org IODP and other marine geology data exploration and visualization tool
- Building Core Knowledge, drilling program paleoclimate inquiry exercises for undergraduate professors and students (book under contract to John Wiley and Sons)
- School of Rock Expeditions for Earth and Ocean Science Educators
- Seven full-color instructional posters with learning activities
- 15+ high production value documentary style videos and animations
- Extensive photo library
- Three traveling kits with core models, microfossil and sediment slides, and microscopes
- Museum programming activity suite based on Cretaceous-Tertiary Boundary or “What happened to the Dinosaurs?”
- 10 prototype museum manipulatives, interactives, or demonstrations, prototype ship’s tour passport
- Artwork, paintings, and symbols for passport stamps and signage
- Tales of the Resolution graphic novel

Table 1. Integrated Ocean Drilling Program and Deep Earth Academy assets available for application to informal programming

The evolution of Ship to Shore Science: DEA Director Leslie Peart returned to sea last July with a team of six educators and communication specialists to work with the science party to interpret IODP Expedition 327 objectives for a multitude of school and museum audiences (IODP, 2010). This was her first time aboard the JR since Expedition 320 in Spring of 2009 when the first experimental video programs were broadcast live to John Jay High School in San Antonio’s Northside Independent School District and to families at a Saturday science event hosted by Oregon’s Treasure Valley Community College. Her time at sea last summer provided an opportunity to observe and test improvements in ship-to-shore programming, and to work with her team to design in-port ship tours for students and families. Both activities required the use of museum-style informal science techniques and principles, thereby setting the stage for development of this informal science proposal.

Creating the ideal ship-to-shore video broadcast or virtual tour has been a challenge that DEA has met through openness to new technology and constant experimentation. Everything that staff try must fit itself into the underlying challenge of using the limited bandwidth and the subtle (or not so subtle) delays caused by satellite-provided Internet link-up at sea. The original dedicated video broadcasting software worked well but was cumbersome for each new client to obtain a license, install, keep up to date, and troubleshoot. The hardware on the ship was difficult to manage with numerous cables and wires, creating
hazardous situations for the facilitators. Over time, we have tested out new software, had multiple software types available for any given instance, improved wireless coverage onboard, and experimented with different laptops, wireless headsets, and cameras. We have worked with partners who have bridged our video feed out to different schools, conducted broadcasts through webinar systems, and prepared programs for structured events and drop-in, on-the-museum-floor venues. We have vastly improved our coordination of requests, confirmation of dates for practices and actual events, and developed a strong set of best practices for different kinds of venues and events. The results have greatly improved, but leave plenty of room for continued refinement and expanding our reach to much greater numbers – hence our desire to work with the teams assembled through Open Space meeting proposed here.

To date, the majority of DEA’s video broadcasts have been to classrooms and to students and/or families in museum auditoriums. Most have taken the shape of ship tours that focus on a brief walk through different labs and discussions with onboard scientists about the current expedition and/or their career paths. However, DEA and onboard education officers have begun experimenting with other types of programming. For example, on Expedition 327: Juan de Fuca Hydrogeology, one video event focused on laboratory safety as part of the participating class’s mandatory training on the topic. During Expedition 328: Cascadia Margin Gas Hydrates, a unique video event took the form of a round table discussion between onboard scientists, informal, and formal educators with education and science staff at the Denver Museum of Natural History. There is a large capacity to expand the focus and approach of video event programming to meet a wide range of audience objectives. This expansion can best be accomplished by developing a network of engaged partners that bring unique perspectives and expertise to the approaches and resources already established by DEA and its partners.

**What We Know About our Impacts:** Our triennial review will not be completed until March 2011, and while we have facilitated 27 live ship-so-shore events for museum and/or family science events, objectives and delivery have varied widely. Qualitative data have been collected from one formal and one informal education event comprising 65 high school-aged female participants. All 65 responses indicate the live events were relevant to the girls’ lives, and/or increased learning about science processes and science careers. This November, DEA staff and the onboard education officer instituted an online survey for video broadcast hosts or facilitators (Appendix 2). With just a handful of respondents to date (n = 9), one hundred percent indicated that they would participate in a JR video event again, and/or recommend it to a colleague. Five of the respondents indicated that the connection to real scientists, student involvement in the broadcast, and/or seeing science in action were the strengths of the video event. Others responded with “It was all great!” and, “it was adapted for my students and our exact content needs.”

The six quotations below provide a representative sample of qualitative assessments and feedback that provide strong evidence for use of informal partnerships and tools like the ship-to-shore broadcasts. The quotes were taken from a variety of live JR video broadcast and informal event participants.

**From a Broadcast Participant to her Teacher on the JR:** Hi Mrs. Kane! I can honestly admit that I am not exactly a science buff, and I have never considered myself as someone who is interested in it, but my idea about science was altered today after Skyping with you and the rest of the JOIDES crew. It was very fascinating to me to observe science in a whole new and modern way. It really made me curious about what you are doing on the JR. I am the type of person who gets inspired by others who really care about the work they perform. Clearly you and the rest of your crew are quite passionate. …Also, when Katerina was answering all of our questions about the ship, the experiments, and daily life onboard, I could actually see myself wanting to go on the ship. Science for me was always something that I was forced to take, and I would think to myself, “when am I ever going to use this in my life?” But now it is really clicking for me. Science can be applied to many things in life, and can actually be very fun as well. I am interested in graphic arts, so it was great to see the graphic designer onboard. …I am very happy to be in physics class…and I am excited to start my own personal journey to loving the world of science!

Meredith, Honors Physics Block 2, St. Ursula Academy, Toledo OH

**Onboard Education Officer:** Many times, the excitement of science for a young person does not come solely from the classroom but from an experience that they had outside of school. They then bring this
into the classroom where the interest can be nurtured. All too often, the classroom exposure is when a teacher is forced to use a pre-made video where scientists are interviewed and then there are brief clips of science being done. Students often ask questions that can only be answered by those appearing in the video, which obviously is impossible. An interested student can lose interest real fast under these circumstances. The numerous Ship-to-Shore events that I have conducted during this expedition have involved classrooms, lunchtime and after school science clubs, and even a neighborhood science program. During the Ship-to-Shore events with these groups, I have been able to adapt, on the spot, to requests. The feedback that I have received has been nothing but positive.

Joe Monaco, School of Rock 2008 and 2009 (from aboard the JR)

**Sixth Grade Teacher:** In the past 18 years of teaching middle school science, I have seen few things so interest my students and get them excited about science as did the experience last year with the scientists on the JOIDES Resolution. The live web cast with the scientists on the JR caught their attention in such a way that it even surprised me! For days following that experience, students had questions about it or wanted to share information they had learned. And then using the website for follow up activities allowed them to really look into the science behind it all!

Jan Fechhelm, School of Rock 2007
Cheetah Team Science Teacher and Instructional Coach
Cypress Grove Intermediate School

**The View from Both Sides:** I had the unique honor to serve as Education Officer on the JOIDES Resolution on Expedition 317: Canterbury Basin. …I conducted videoconferences with my students and with students from around the country, and even in Europe. All the audiences were universal in their curiosity and keen interest in what the ship and its expeditions were capable of. Students this year have referred back to something they learned from a video conference or the Google Earth and web quest activities we did connected with the expedition. That real world connection has made the learning concrete and long term for them. I have also been on the audience side of two videoconferences with the JOIDES. …we connected with the ship from a programming room at a Science Fiction Convention in Dallas. At first, this may seem an unusual audience, but the Science in Science Fiction is really the focus. There was a large audience who was engaged and curious and had great questions about the future of ocean drilling and what more we can hope to learn.

Julie Pollard, 7th and 8th Grade Science Teacher
Wautaga Middle School

**Staff Scientist about a Museum Setting:** As an IODP Staff Scientist and Expedition Project Manager I was involved in several educational activities and have noticed the amazement of students and the general public whenever they learn about our drill ship and the fascinating science that can be addressed by drilling into the ocean floor. I will never forget the moment when a young, about 10 year old Japanese girl, in a live video chat from the drill ship with the Museum of Nature and Science in Tokyo asked me: “But how can you drill from a ship that moves up and down on the sea?” All the time we were talking about the scientific background of the expedition and life on board and then we got such a fundamental question from this little girl. Apparently nobody from the adult audience thought about this fundamental technical problem (or was too shy to ask). The question of this girl was particular significant since one of our outreach goals (although at a different broadcast) was to encourage female Japanese students to get more interested in science and technology.

Jörg Geldmacher

**Ship-to-Shore Science in the Living Room:** I am writing with my sincere thanks for the programs you run through the JOIDES Resolution. I am a physician and live in a small town in upstate NY. The programs and outreach you provide are invaluable in exposing the children in our area to amazing science opportunities and research. I run an after school science program for area children and work closely with the Childrens Museum of Central NY. Through your programs we have had a scientist come
to our community to conduct programs for both adults and children. The children have had the amazing opportunity to skype with the JR. ...These children have learned a tremendous amount and are exposed to parts of the world they would otherwise know nothing about. The children have participated in the Adopt a Microbe program - each of these programs has been different enough that they continue to learn through each experience. I cannot thank you enough for your efforts in bringing STEM education directly to our homes. The children feel they are actually a part of these missions.

Dr. Beth Bulawa

The first four quotes embody feedback received by video broadcast participants in formal settings. Since the first School of Rock in 2005, we have recognized the strong correlation between IODP, the JR, and regional and national content standards (Table 2); and the ease at which classroom teachers and informal education specialists can adapt and use the 40-year drilling program legacy of core samples and data generated by the JR and her predecessor, the R/V Glomar Challenger (Leckie, et al, 2006). Fechhelm and Pollard also speak to extended learning through follow-up activities and inquiries utilizing joidesresolution.org and Google Earth, most of which were developed by School of Rock participants and Onboard Education Officers.

Table 2. Comparison of (A) select scientific ocean drilling practices and discoveries with (B) relevant education content standards (National Research Council, 1996). PETM__Paleocene-Eocene Thermal Maximum (from St. John, et al, 2009)

The last three quotes above demonstrate feedback typical of informal audiences. The consistently positive feedback suggests DEA’s live video events may be a powerful tool for life-long and life-deep learning (Banks et al, 2007), especially when linked to additional pre- and post–event learning activities. There is an extra challenge to providing such activities to informal audiences because they are often a
conglomerate of people or families from different places with varied interests and backgrounds. Some may not even know about a video event until they arrive at the venue, and/or their participation is not part of a course with specific objectives. Getting pre-information to them in the ways that DEA has used with classroom teachers, i.e. by sending them to our websites, videos, and introductory activities, is not necessarily a feasible or effective approach. Finding creative solutions to this challenge – like developing exhibits that can prepare and extend a person’s experience – is an important step for improving and enhancing DEA’s impact on science learning and appreciation.

Dr. Bulawa’s comment also brings family learning to the discussion. Families are the largest museum constituents and can help to expand DEA’s audience, especially in communities where Earth and ocean science are not included in the school curriculum. Family learning is an example of, and has all the benefits of social learning, and the latest BayerFacts study (2010) finds that regardless of gender, race or ethnicity, interest in science begins in early childhood. Participating in a virtual tour of the JR, meeting and talking with Earth and ocean scientists as a family in a free-choice setting may help steer children toward these often overlooked career paths (Hoisch, 2010) and pave the way for teachers, who are still identified as the number one influence on career choice (Bayer Corporation, 2010). In this way, the JR might serve as a link between informal and formal settings.

Clearly, more detailed and specific information is needed in order to move these programs to the next level. To proceed towards our goals of determining how to fully and best utilize the tremendous resource of the ship and its staff, it is necessary to collect additional quantitative and qualitative data. DEA intends that this data will also help to answer the need for research about (1) how people are introduced to scientific tools as a means of engagement in informal environments and/or the use of scientific tools in designed environments, and (2) increased acquisition of knowledge through experiential learning activities before and/or after a live video event (NRC, 2009).

**Results from Prior NSF Support:** Two NSF agreements support the Deep Earth Academy (DEA): (1) NSF Contract OCE-0352500 (Integrated Ocean Drilling Program United States Implementing Organization) David Divins, Principal Investigator, (2003-13, $626,217,308), and (2) NSF Cooperative Agreement OCE-0652315 (U.S. Science Support Program USSSP, Jeff Schuffert, Principal Investigator, (2007-14, $42,361,019). DEA’s budget is a small fraction of these two agreements that provide funding for the ship’s operations and scientists in the program. The DEA budget is meant to provide avenues for broader impacts. Many of our results have been discussed above and we include a synopsis of our history here:

Since 2005, more than 120 educators and scientists have participated in DEA’s School of Rock Expeditions for Earth and Ocean Science Education, or as onboard education officers, and have published more than 100 learning activities, videos, posters for K-12, undergraduate, and informal audiences, thousands of which have been distributed through almost 150 workshops, presentations, and science and education conferences in the U.S. and around the world; and online through the JR and Deep Earth Academy websites. In addition, DEA develops and facilitates ship-to-shore education programs through its joidesresolution.org website, social networking tools, and video productions, all of which are managed by onboard education officers selected through a nationwide solicitation. Since launching the rebuilt R/V JOIDES Resolution drill ship in March of 2009, 100 live broadcasts have been conducted to approximately 13,000 participants at more than 100 schools, museums, family learning events and professional meetings in the U.S., Japan, France, Scotland, Australia, Canada, Mexico, New Caledonia, India, Italy, Spain, and the Netherlands. DEA also facilitates at least three museum-based learning events per year in conjunction with the USSSP Distinguished Lecture Series. School of Rock and our shipboard programs have been featured as highlights in NSF’s Budget Request to Congress, in the American Geological Union’s EOS and a special publication of the Geological Society of America. For more selected publications, see PI Peart’s CV. A triennial evaluation of our impacts will be completed in March 2011. USIO, USSSP, and DEA are programs of the Consortium for Ocean Leadership in Washington, D.C.
ii. Project Design

**Project Management:** Together, DEA Director and Principal Investigator Leslie Peart, Assistant Director and Co-Principal Investigator Sharon Cooper, and Teacher in Residence Jennifer Collins have more than 25 years of experience in museum, zoo, and aquarium education programs. In addition, IODP Communications Manager Kristin Ludwig has both museum and virtual ocean education program experience. Peart and Cooper will each devote one calendar month or 8% of their time to oversee *Ship to Shore Science.*

**Roles and Responsibilities:** PI Leslie Peart will provide overall project direction, including advisory panel meetings, budget, external evaluation, venue and pilot project selections and implementation, and School of Rock leadership. Peart became director of DEA in 2004 after 13 years diverse South Texas classrooms and 10 years in public aquaria including the Texas State Aquarium, Alaska SeaLife Center (where she served as the inaugural education director), and John G. Shedd Aquarium.

Sharon Cooper will assume responsibility for the Open Space meeting planning and facilitation, including compilation, synthesis and communication of meeting results. Cooper will also provide support for venue and pilot project selection, implementation, and synthesis, and School of Rock. Together, Peart and Cooper will moderate the online workspace. Ms. Cooper has been with Deep Earth Academy since 2007. Prior to that, she was the educator on the core team developing the Smithsonian’s Sant Ocean Hall. She has also worked as a contractor doing education work for NOAA and has a background in informal and conservation education.

As a part of her regular assignments at DEA, Jennifer Collins will be responsible for internal evaluation and School of Rock management. Ms. Collins joined DEA through a 2008 teacher fellowship. Collins’ background and talents quickly propelled her to the status of Teacher in Residence, a regular, long-term position focused on School of Rock, teacher professional development, and curriculum development, in addition to work with museum and informal science programs.

**Implementation:** *Ship to Shore Science* will convene a group of informal programming experts, scientists, and programming end-users to assess how best to use the education assets of the *JOIDES Resolution* (JR) and Deep Earth Academy (DEA) or design new tools to capture the attention of selected family, museum, student, scout, online, radio, high tech and/or television audiences. Through the use of an Open Space technology meeting, the group will conduct a font-end needs assessment and gap analysis, then select and pilot content and methods designed to connect informal audiences to this world class research ship for increased awareness and understanding of the nature of science, fundamental Earth and ocean science principles, and careers in science, technology, engineering and math (STEM). These strategies strongly reflect the National Research Council’s Committee on Learning Science in Informal Environments’ recommendations for exhibit and program designers (NRC, 2009):

- **Recommendation 2:** From their inception, informal environments for science learning should be developed through community-educator partnerships and whenever possible should be rooted in scientific problems and ideas that are consequential for community members.

- **Recommendation 3:** Educational tools and materials should be developed through iterative processes involving learners, educators, designers, and experts in science, including the sciences of human learning and development.

**Advisors:** We will select and assemble a group of eight advisors, stakeholders representing IODP scientists, “sister” Earth or ocean science programs, informal science experts, virtual field-trip providers, teachers, and diverse life-long audiences including parents, pre-school providers, and elder learners. The advisors will recommend and help select the broadest possible group of participants and develop the vision and goals for an Open Space meeting, provide access to results of exemplary ship and field-based learning programs, and help to select and assess pilot programs. The advisors will meet face to face during the first and last quarters, participate in the Open Space conference during the second quarter and meet through video conferencing technology for the duration of the project.
The Open Space Meeting: We propose to hold a 2.5 day Open Space Technology conference as a kick-off for bringing together all the relevant stakeholders, framing our future discussions, choosing the most pressing content, learning goals, audiences, and methods on which to focus, and forming the strategic partnerships and connections that will be the backbone of this work going forward. The meeting will be conducted during the second quarter of the project. Co-PI Cooper is experienced with Open Space, having implemented a conference of 80 participants in preparation for education programs prior to the opening of the National Museum of Natural History's Sant Ocean Hall. Even so, an external facilitator will be essential to the elimination of bias. The facilitator will be selected through a competitive process beginning with a request for proposals to be issued simultaneously with the submission of this proposal.

Open Space Technology: Open Space Technology is an inspiring, transformative, creative and highly effective format for running meetings. In Open Space meetings, participants create and manage their own agenda of parallel working sessions around a central theme of strategic importance, such as: What are the strategies and groups that all stakeholders can support and work together to create? What partnerships will be most important to moving this work forward?

Open Space methodology has been used and well documented worldwide (http://www.openspaceworldscape.org/) by hundreds of corporations, organizations, and other groups to grapple with particular issues of importance to them (http://www.openspaceworld.org/cgi/wiki.cgi?OpenSpaceExamples/Conferences). The Open Space approach is characterized by five basic mechanisms: (1) a broad invitation that articulates the overall purpose of the meeting; (2) participants arranged in a circle; (3) a "bulletin board" of issues and opportunities created and then posted by participants; (4) a "marketplace" of breakout spaces that participants move freely between, learning and contributing information and ideas; and (5) a pattern of flow between plenary and small-group breakout sessions.

The approach is most distinctive for its initial lack of an agenda, which creates the space for the participants to develop the agenda themselves, in the first 30–90 minutes of the event. Typically, an Open Space meeting begins with short introductions by the leaders and a single facilitator. Leaders introduce the purpose and frame the discussion; the facilitator explains the "self-organizing" process of Open Space. The group then creates the working agenda, as individuals post their issues in bulletin board style. Each individual who posts a given issue becomes the "convener" of that breakout session and takes responsibility for naming the issue, assigning it a space and time to meet, and then later, arriving at that space and time, starting the conversation, and recording notes. These notes are compiled from all sessions into a proceedings document that can be distributed physically or electronically to all participants before the meeting’s end. Towards the end of the meeting, the whole group is reassembled to look at key outcomes, assign priorities and identify follow-up actions.

Why Open Space? The Open Space format is ideally suited to meetings and tasks that center on brainstorming, inventory-taking, and connection building – all of which are critical to this proposed work. As Open Space practitioners describe, Open Space works best when the work to be done is complex, the people and ideas involved are diverse, and the passion for resolution is high. It has been called “passion bounded by responsibility,” and a simple, powerful way to get people and organizations moving -- when and where it is needed most. These conditions are all met by the Ship to Shore Science project proposed here. Rather than a top-down approach dictated solely by the PIs or advisors – or any single group - this methodology levels the playing field for all participants and literally “opens the space” to welcome ideas and connections from all appropriate partners. It is a tremendously creative process that generates excitement and energy in the rooms in which it takes place, and for the work that will follow.
Open Space leaves the door open for unexpected and surprising results. As Michael Hermon, a long-time facilitator of Open Space meetings writes:

*We can guarantee these results when any group gets into Open Space:*

1. **All of the issues that are MOST important to the participants will be raised.**

2. **All of the issues raised will be addressed by those participants most qualified and capable of getting something done on each of them.**

3. **In a time as short as one or two days, all of the most important ideas, discussion, data, recommendations, conclusions, questions for further study, and plans for immediate action will be documented in one comprehensive report -- finished, printed and in the hands of participants when they leave.**

4. **When appropriate and time is allowed for it, the total contents of this report document can be focused and prioritized in a matter of a few hours, even with very large groups (100's).**

5. **After an event, all of these results can be made available to an entire organization or community within days of the event, so the conversation can invite every stakeholder into implementation -- right now.**

6. **AND... results like these can be planned and implemented faster than any other kind of so-called "large-group intervention." It is literally possible to accomplish in days and weeks what some other approaches take months and years to do.**

The Open Space meeting proposed here will consist of approximately 30 participants. It is essential to bring together all of the right stakeholders, so our advisory group will be critical to generating the list of attendees. During the start of the actual meeting, the parameters will be set forth by the PIs and their advisors – essentially framing the central questions:

- What informal science tools and models (both existing or yet to be created) are/will be most effective for sharing the excitement of the JR and her Earth science work with students, teachers, families and the general public?
- How can existing models be leveraged to grow the program?
- What partnerships need to be created to most effectively move this work forward?

The plenary session(s) will include one or more live ship-to-shore broadcasts from IODP Expedition 336 – MidAtlantic Microbiology, hands-on opportunities with cores and drilling artifacts, and visits with IODP scientists and ship staff. Participants should be familiar with JR and DEA education assets before the meeting, but not bound or limited by them in any way.

After the meeting, all results will be posted on-line in interactive forums where the participants can continue to comment and cross-pollinate sessions in which they may or may not have participated. Any stakeholders who were unable to attend the meeting will also be able to see these results. This open, on-line interaction will be available and comments will be collected for one month after the Open Space meeting, at which time all participants will also be asked to prioritize the issues, most likely the Earth and/or ocean science content, learning goals, audiences and delivery methods or tools they recommend for pilot projects.

**Pilot Projects and Core Teams:** We anticipate that the Open Space meeting will generate a number of strategic partnerships, consisting of the people and informal organizations most appropriate to address each of the priority issues (science content, learning goals, audiences, methods) through pilot project development and assessment. This proposal includes funding for work on three to five such projects to be identified by the advisors based on the priorities set forth from the meeting and online forum results. If more than five pilot project ideas are generated by the meeting, the advisors will request and evaluate proposals in consultation with the Open Space facilitator and *Ship to Shore Science* staff. The priorities and decisions will be informed by the National Science Education Content and Teaching Standards (NRC, 1996), the Earth Science Literacy Principles (http://www.earthscienceliteracy.org/document.html)
and the Ocean Literacy Framework (http://oceanliteracy.wp.coexploration.org/?page_id=47), and should highlight science in action during IODP expeditions on the JOIDES Resolution.

Once the pilot project partnerships are determined, each will nominate one exhibit developer, one education specialist and one evaluator to form a Core Team. The Core Teams will attend the 2012 School of Rock Expedition for Ship to Shore Science Pilot Project Development (SOR), an expedition or program designed especially for this purpose and funded through DEA’s annual USIO budget. SOR is generally a two-week, hands-on discovery expedition for Earth and ocean science teachers, university faculty, and museum professionals aboard the JR. Working with IODP scientists, technicians, ship’s crew and staff, the 2012 Core Teams will participate in a broad range of methods used by shipboard researchers during a typical expedition to sample and analyze cores and data. As such, SOR is a truly social (Bandura, 1977), experiential (Kolb, 1984), and situated (Lave and Wegner, 1989) learning program, qualities that should also be incorporated into the pilot projects.

SOR participants are always asked to adapt or create new IODP-related learning activities and 2012 will be no exception. Each Core Team will be asked to draft a pilot program during the expedition. All Ship to Shore Science projects will be guided by the National Science Education Standards, which have been used by many institutions to inform and improve practice (Yager and Falk, 2008); and must adhere to the principles outlined in the Committee on Learning Science in Informal Environments’ Recommendations 1 and 4 for exhibit and program designers and front-line educators (NRC, 2009), key among them the facilitation of learning across multiple settings, in this case the JR, museums and/or schools.

**Recommendation 1:** Exhibit and program designers should create informal environments for science learning according to the following principles. Informal environments should

- be designed with specific learning goals in mind (e.g., the strands of science learning)
- be interactive
- provide multiple ways for learners to engage with concepts, practices, and phenomena within a particular setting
- **facilitate science learning across multiple settings**
- prompt and support participants to interpret their learning experiences in light of relevant prior knowledge, experiences, and interests
- support and encourage learners to extend their learning over time

**Recommendation 4:** Front-line staff should actively integrate questions, everyday language, ideas, concerns, worldviews, and histories, both their own and those of diverse learners. To do so they will need support opportunities to develop cultural competence, and to learn with and about the groups they want to serve.

Living aboard the vessel, the teams will become a true community of practice (Wenger, 1998), and will provide a first round of critiques and suggestions for each other before posting their plans on the Ship to Shore Science online workspace. As noted above, the Ship to Shore Science pilot projects should promote social, experiential and or situationed learning and should build capacity among team members. While the Core Teams will develop independent projects, the evaluators will work as one group to craft a common set of audience interview questions and feedback protocols for use in assessing the effectiveness of all the pilot projects. The common interview questions will also be posted for comment.

Because the projects should focus on science in action, project construction, development, and/or front-line staff training must be finalized in time for the next round of expeditions that are slated to begin in the North Pacific in June of 2012. This will allow the Core Teams four and a half months for design, development and construction (see timeline below). Progress will be reported at least monthly via the Ship to Shore Science online workspace, where all participants (advisors, Open Space participants and Core Teams) may review, reflect, question and share ideas.
Pilot projects and audience interviews (at least 20 per site) will be implemented during the IODP Cascadia and Southern Alaska expeditions, a three month period between June and September of 2012. Once completed, the assessments will be compiled, collated, analyzed, and posted online for review by IODP management, *Ship to Shore Science* Staff and participants. The advisory panel will once again be assembled to select the most effective projects and path(s) forward. Our findings will also be assembled into a report and demonstrations that can be presented at the Association for Science and Technology Centers Annual Conference and National Science Teachers Association Regional Conferences in the fall, and the American Geophysical Union's Annual Meeting in December. The project period will effectively end in December, however we anticipate moving forward with our new partners in the development of a preliminary Full-Scale or Broad Implementation proposal based on the most successful pilot project(s).

**Evaluation:** Ship to Shore Science is a front-end assessment that will provide the data needed to assess how best to use the education assets of the *JOIDES Resolution* (JR) and Deep Earth Academy (DEA) or, if necessary, design new tools to capture the attention of selected family, museum, student, scout, online, radio, high tech and/or television audiences. Through Open Space technology, *Ship to Shore Science* will:

- Refine and select the very best methods for sharing the excitement of the JR’s transformative and cutting-edge science, the nature of science and STEM careers with shore-based informal audiences
- Develop prototypes and partnerships to showcase, assess and share these methods
- Disseminate awareness and knowledge of JR-based key to our understanding of fundamental Earth processes science throughout the U.S.

To achieve these goals, the program evaluation will utilize a combination of quantitative and qualitative, formative and summative methods; and employ both internal and external evaluators in an integrated approach consistent with a mixed methods philosophy that emphasizes evidence based designs and outcomes. The evaluation process will utilize Stufflebeam’s CIPP model: Context evaluation, Input evaluation, Process evaluation, and Product evaluation (Stufflebeam, 2007). Context evaluation identifies the needs, assets, goals and problems of the program. Input evaluation addresses the resources, budget, and strategies utilized in addressing the goals and/or objectives of the program. Process evaluations monitor, document, and assess program activities. Product evaluation is the final component and focuses on analysis and evaluation of the data in support of the stated program goals and/or objectives. Or more succinctly, the CIPP model asks (and answers) four questions: What needs to be done? How should it be done? Is it being done? Did it succeed? And CIPP hopes to answer with the project’s merit (quality), worth (meeting needs of partners and target audiences), probity (integrity and transparency), significance (broader impacts) and lessons learned.

The CIPP model was chosen because it is an on-going process that emphasizes evidence-based decision-making in program management rather than simply reporting the final results of the program. The CIPP model was also chosen because it is a comprehensive program evaluation model that allows for quantitative and qualitative data collection and is not limited to preset goals and objectives – an approach consistent with the iterative process of the Open Space process we plan to implement. Finally, the CIPP model is a proactive, integrated program evaluation model that emphasizes interaction between program staff, participants and evaluation team.

DEA Teacher in Residence Jen Collins will serve as internal evaluator. An external evaluator will be selected through a competitive request for quotes (RFQ) this spring. We anticipate revising and refining the evaluation plan once an external evaluator has been selected, however the Statement of Work and subsequent RFQ will include evaluation of: 1) participation and productivity of staff and advisors in defining goals and objectives, and planning the Open Space conference; 2) participation and productivity in a continuously operated online participant forum, which will serve as a secure online working space for Open Space participants and Core Teams to provide Input and Process Evaluation information; 3) provide feedback/consultation on formative assessments designed and implemented by the internal evaluation team on an as needed basis (Process and Product); 4) oversee and consult with the Core Team evaluators as they develop a common list of audience assessment questions and interview
protocols for summative assessments of the pilot projects (Process and Product); and 5) consult with Collins to implement appropriate summative assessments as part of the Product Evaluation. NOTE: The Consortium for Ocean Leadership, and therefore DEA, are bound to follow rigorous Federal Guidelines and procedures for soliciting and selecting contractors. The process can be lengthy and would have been difficult in the time available between notification of the preliminary proposal’s success in September and the final submission in early December.

Collins and Peart will assist the external evaluator in the identification of advisors, stakeholders and objectives and with organizing and managing the process. Because needs may change over time, these objectives will be revisited on a periodic basis based upon the recommendations of the external evaluator. As noted previously, an advisory panel of eight stakeholders will provide guidance and vision for the Open Space conference, and ensure the greatest possible diversity in stakeholder participation. Stakeholders will include a mixture of scientists, informal science and K-16 educators, parents, and IODP representatives.

**Context and Input Evaluation:** The Open Space conference that will identify our needs and key objectives for moving forward comprises the Context Evaluation phase. During the Input evaluation phase, the internal and external evaluators will work with Ship to Shore Science staff and advisors to evaluate existing resources and models (Table 3) that address objectives to be developed in the Context Evaluation. The external evaluator will also introduce the online forum that provides a tool for continued dialogue among all participants. This forum will be used to manage, monitor and evaluate internal, Open Space participant, and Core Team activities for the duration of the project. All project outputs and outcomes will be identified, assessed, improved, and retained within this collaborative environment.

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Table 3. A brief list of formal and informal science education programs with characteristics similar to those of Ship to Shore Science

**Process and Product Evaluation:** These phases of the evaluation, to be coordinated by the external evaluator, will include (1) the development and implementation of the common audience interview assessment tools, (2) collection of formative pilot project information and feedback, (3) synthesis of process data and information collected through the online forum, (4) the final summative report and (5) suggestions for a follow-on Full-Scale Development or Broad Implementation Proposal. The external evaluator will work with the Core Team evaluators during School of Rock to develop the common interview questions and protocols (a feature we feel may be unique to our program), and may develop a comprehensive formative and summative evaluation plan utilizing a Logic Model for use during pilot project development and implementation.

The evaluation plan will monitor and assess the viability and capacity of Ship to Shore Science and its pilot projects through qualitative and quantitative performance metric data in the following areas: number and demographics of active participants; descriptions of supported activities, their objectives, and expected outcomes; documentation of stage of development of pilot project and Ship to Shore Science staff activities; pilot project results; and consultation on the design of the evaluation plan for the anticipated follow-on proposal. The CIPP Evaluation Model Checklist available through Western Michigan University will guide the CIPP evaluation (Stufflebeam, 2007).
Ship-to-Shore Timeline and Deliverables
(Note: See detailed JOIDES Resolution Expedition Schedule in Appendix 3)

15 Jun – 15 Jul 2011
• Finalize selection and contractual arrangements for external evaluator and Open Space meeting facilitator; finalize external evaluation objectives and plan

15 Jul – 15 Sept
• Assemble advisory panel to plan Open Space meeting; work with advisors to compile meeting participant list with as many potential stakeholders and audiences as possible
• Complete behind-the-scenes logistical planning for Open Space meeting (location, hotels, etc…)
• Conduct Input Evaluation; introduce online forum and workspace

15 Sept – 15 Oct 2011
• Conduct Open Space meeting, which will include one or more live ship-to-shore broadcasts from IODP Expedition 336 – MidAtlantic Microbiology, hands-on opportunities with cores and drilling artifacts, and visits with IODP scientists and ship staff
• Complete Context Evaluation

15 Oct – 30 Nov 2011
• Open Space facilitator, staff, and advisors review meeting outcomes and select three to five audience/science content/delivery mechanism combinations for pilot program development
• Pilot program venues select Core Teams (design, education, and evaluation personnel), one team per venue

1 Dec 2012 – 1 Feb 2012
• Core Teams and external evaluator attend School of Rock short course (associated with IODP Mediterranean Outflow Expedition) and draft ship-to-shore programming, complimentary exhibit or activity design, and common assessment interview questions and audience feedback protocols

1 Feb – 15 Jun 2012
• Core teams will complete pilot ship-to-shore program, complimentary exhibit construction, assessment tools, and front-line staff training

15 Jun – 15 Sept 2012
• Conduct pilot programs with live broadcasts and/or other transmissions from IODP Cascadia and Southern Alaska Expeditions
• Complete audience feedback interviews

15 Sept – 15 Nov 2012
• Evaluators compile and analyze audience interview data to complete Product Evaluation
• Staff and evaluators prepare and distribute report(s) for advisors, IODP management, and/or publication and dissemination through professional meetings
• Present findings at Association for Science and Technology Centers annual meeting, regional NSTA conferences

15 Nov – 15 Jan 2013
• Evaluators complete Process evaluation
• Assemble advisors to select best path(s) forward for full scale proposal development
• Solicit program partners, create and release a request for evaluation proposals for new proposal
• Present findings at American Geophysical Union annual meeting in December

15 Jan – 15 Mar 2013
• Select program evaluator and partners for new full-scale development proposal

15 Mar – 15 June 2013
• Create new full-scale development proposal(s) based on pilot program findings