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Chapter 11

Collaborating Across the University/Informal Boundary: Broader Impacts Through Informal Science Education

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In this chapter we present the ways in which institutional cultural differences impact the development and implementation of learning activities in informal settings. Five university-based centers for the study of chemistry worked with informal learning professionals to re-envision educational and public outreach activities about science. The projects were part of a broader effort to catalyze new thinking and innovation in informal education and chemistry centers. The set of projects illustrates the broad possibilities for informal learning settings, with projects targeting diverse audiences with a range of experiences including an interactive exhibit at a major science center, activities for an small drop-in science club for disadvantaged teens, curricula for organized afterschool and summer camp programs, audio science stories for a general audience, and a fellowship training program for informal educators and scientists. We highlight the ways in which professionals working in universities and informal settings structured their collaborations and reflect upon the conditions that led to success on a range of dimensions.

Historically, outreach has been a part of large multi-investigator science centers funded by the National Science Foundation (NSF) in the USA. In addition to their core scientific research missions, these centers conduct education and public outreach activities that take many forms, including both short and longer-term programs or one-day events. Centers might fund internship programs for undergraduate or graduate researchers; providing a structured training opportunity for young scientists. High school students might have a weekend-long program to learn about science in a specific area. These kinds of outreach activities are often organized around demonstrable outcomes that positively impact the career pipeline for future scientists. These kinds of outreach programs have a formal structure and serve the goals of the higher education system. Centers also develop experiences for general public audiences. These activities might include lectures, participating at tabled events, or more recently, working at dialogue-based events like science cafés. In many cases outreach activities fall to academic staff who do not necessarily have expertise in facilitating these kinds of less structured and informal experiences or working with public audiences of varied ages and backgrounds (Andrews et al, 2005). Whereas public outreach is an activity that may be seen as necessary and desirable, its impacts are harder to document (Brown et al, 2014; Neresini & Bucchi, 2011). The structure of academic science programs provides no reward system for these endeavors, and scientists often feel that they do not have the time or the skills to implement innovative programs and activities for public audiences (Risien & Falk, 2013).

In 2009, in light of these and other concerns, NSF re-examined its grant criteria, and decided that grantees should place more emphasis on the quality and quantity of outreach communication, requiring all research proposals (not just the large centers) to explicitly address the “broader impacts” of research on science, education, and society. Broader impacts criteria include wide dissemination, increasing infrastructure for research and education, reaching under-represented groups, engaging the public and K–12 audiences, and providing professional development for teachers or early career researchers. Importantly, broader impacts criteria are to be as rigorously considered as intellectual merit during proposal reviews. With its desire to better connect society and science, the new broader impacts criterion is noble, but in practice improving broader impacts and outreach remains difficult (Alpert, 2009).

As an experiment in strengthening broader impacts work, in 2012 NSF initiated a special project for its Centers for Chemical Innovation (CCI) that was designed to encourage mutually beneficial and sustainable collaborations between science, technology, engineering, and mathematics education (STEM) researchers and informal science education professionals. The CCI's are large multi-institutional research centers where scientists work on long-term challenges within targeted areas of chemistry, such as solar energy, chemical evolution or catalysis. CCI's are heavily university-based but they may partner with researchers from industry, government laboratories, or international organizations. CCIs are "tasked to integrate research, innovation, education and informal science communication" and it is hoped that by bringing together researchers with shared and complementary interests a culture of risk-taking and innovation will result (NSF, 2013).

The Informal Science Education initiative was created for CCIs to encourage collaboration between the centers and informal science professionals in order to develop awareness of and expertise in working with informal science education (ISE) practices, and to ultimately improve the quality and expand the scope of education and outreach activities provided by these centers, and scientists more generally. The funding for these collaborations was framed as seed money, with the goal of catalyzing new collaborations with informal educators to experiment with novel and innovative approaches. As they searched for informal education collaborators and formulated project ideas in response to the grant, many of the centers made use of the resources of the Center for Advancement of Informal Science Education (CAISE), including consulting with CAISE staff and using the materials on its web site (http://informalscience.org). The centers had five different visions of project type, audience, and manner of working with partners. The experiences produced included an interactive museum exhibit, afterschool science programs, audio spots, activities for a drop-in science club, and a professional development environment.

The Research Study

Our study of this funding experiment explored project collaboration and the issues and challenges faced by new partnerships, as well as the impacts and innovative aspects of the projects. Data collection involved structured interviews with staff in each of the projects, including center scientists, center education and public outreach coordinators, and informal science professionals. Interviews were transcribed and coded for themes and patterns. We also analyzed documents and products from the partnerships. Follow up interviews with each project team were conducted six months later to document project progress and clarify our emerging themes.

Our analysis focused on how university-based scientists approached the challenge of collaborating with informal learning partners, what they learned from the collaboration, and various ways we might consider success in light of varying measures of impact, innovation, and sustainability. Specifically, our guiding research questions were:

1. What was the nature of the relationship between partners before the partnership and what is it like afterward?

2. What impact did the partnership have on each partner (e.g. changes in understanding of each other's culture, success of the product/services developed during the supplemental grant)?
3. What is the probability that the relationship will be sustained and how will it be the same – or different as it moves forward?
4. What are the characteristics of the partnership(s) where the greatest understanding of each other's culture occurred? What are the characteristics of the partnership(s) where the probability of sustainability is the greatest?

Overview of the Five Cases

Exhibit. One center developed an interactive exhibit that would fit within an existing exhibition on energy at a large science center in an east coast U.S. city. An interactive computer-based touch table was designed to communicate the role of catalysts in speeding up reactions essential for creating products from petrochemicals. The activity allows users to create chemical pathways that take fossil fuels and turn them into molecules responsible for common items that use petrochemicals, such as aspirin and lipstick. The project was envisioned as a way to reach the general public and develop an awareness of the vast and significant ways that we use fossil fuels. In terms of process, exhibit designers at the museum were connected with a CCI member, an assistant chemistry professor and students at a nearby university. The academics were invited to brainstorm meetings with museum staff. Students then created prototypes for the exhibit as part of their classwork. Students' ideas were important fodder for the exhibit design team, and their professor continued to provide input into later stages of development. Whereas scientists learned something about informal education and museums by working with museum staff, this was primarily a consultative process. The resulting exhibit is engaging and educational, reaches a large audience of adults and children and relays important science concepts germane to the work of the research center. Whereas the science content communicated is relevant to science of the center, the need to be accessible and interactive somewhat impacted the depth of concepts that could be tackled in this format.

Media. A center in a large southeastern U.S. city partnered with an independent radio producer to develop audio stories aimed at enriching public science literacy. Audio segments used a variety of techniques including standard public radio narrative style, short scientist-narrated nuggets, and imaginative explorations of key chemistry concepts. Scientists in the center also worked with the producer to develop their communication skills, as authors and creators of audio pieces. Live performances that used content from the pieces were also staged. Before this collaboration, the center had a long history of working within the university community on innovative arts-based outreach projects, so the team was excited to try out a new media format. The producer worked with staff to develop stories that could serve as a bridge between public interest and the complex kinds of chemistry concepts that the center focused on. He also offered a workshop for 20 chemistry students on radio production skills in addition to the narrative story crafting skills required for the project. Three professional development events were also conducted at two universities during the course of the project.

Afterschool. A center in in a west coast U.S. city worked with an on-campus educational resource center to deliver hands-on science programming to engage participants (age 8-12 years old) in STEM activities in afterschool settings, as well as during a four-day summer camp for 8–9-year olds. This particular university had an existing educational outreach group that, among other things, was already developing and delivering STEM content and working with teachers. As the ISE partner, staff members from the educational outreach group were central to the project, developing and coordinating the activities with student teachers, and implementing many of the lessons at the club. The outreach coordinator from the chemistry center worked closely with outreach staff and attended nearly every program to see lessons in action. She was the connection to center scientists. One ongoing challenge for the project was to connect the challenging science content of the center to the outreach activities for children of this age. The team worked hard to find ways to connect the science of the center to hands-on experiences. The initial intent was for the afterschool club to take over the implementation of the designed activities, with the team providing the activities and training for instruction for the boys and girls club staff. However, low science knowledge/ interest as well as turnover of staff at the club required that the partnership continue to provide instructors for the activities.

Science club. Another center in a west coast U.S. city created a set of activities for an afterschool neighborhood club for local youth. This partnership was very collaborative, with the informal partner working with faculty and post-docs to develop and deliver outreach activities at the club. Workshops were held to help scientists become oriented to the ISE field. Several post-doctoral fellows were closely involved in the process, attending programs at the club, and becoming part of the club's culture. This club is small and intensive, with about 8–10 regular kids, and this provided an opportunity for the scientists to see that they were making some very real impacts on children's lives with science. The team developed 15 modules focused on chemistry. The development process involved creating mind maps for the youth and relating them with topics of scientific research at the center. The first year also involved field trips. For the second iteration, the team decided to focus on a few of the modules in more depth, expanding them to two-month activities each with four sessions. Although general chemistry was covered, there was also a focus on topics were more closely related to the cutting edge chemistry research of the center. For a field trip the club went to a hydrogen filling station. Youth looked at fuel cells and did projects on polymers and visited an advanced lab. Partners felt that the partnerships developed in this project would extend beyond the life of the grant, and additionally post-doctoral fellows working on the project told us they are now rethinking their career direction to include a stronger focus on science communication.

Professional development. Finally, a center based in a northwest U.S. city worked to develop a strong partnership between scientists and museum educators to lead to a deeper understanding of each other's practice. Calling themselves a “Partnership for Public Engagement,” the project mounted a series of professional development seminars that brought together scientists and informal educators. During the seminars, scientists introduced museum staff to their research interests and research. Museum staff worked with researchers on science communication skills and issues. The cornerstone of project involved the creation of a fellowship program for student scientists to work on ISE activities with museum staff. This program recruited participants by application and three grad students and postdoctoral students were selected. During their meetings museum staff and fellows worked on designing and testing outreach activities based on the scientific research of the center. A template for program design was created and, through joint discussion, museum staff realized that their template required more specificity for use by those outside of the ISE field. These revisions helped the team to better address language issues involved in communicating with a broad range of public audiences. Center fellows engaged in prototyping program designs and found it an enlightening process, helping them to understand first-hand the communication challenges of working with different audiences. Fellows also learned about the particular challenges in developing hands-on activities for informal settings. Museum staff report that they are much more comfortable with the science and the scientists, and fellows love working with the museum. The project planned to continue the fellowship program with other funding, and look for future opportunities to collaborate in other areas.

Structuring the Collaboration

In each case, the center was required to form a new collaboration with an informal learning entity, although the cases varied in the degree to which the collaboration was novel and/or ambitious. We consider the cases first in terms of the three distinct models they took to collaboration: hand-off, training, and collaborative.

Scientists hand off the implementation to informal educators. The hand-off model was most clearly implemented by the museum exhibit and afterschool cases. The design and delivery of learning experiences was deemed to be largely the role of the informal learning staff, with center scientists playing the traditional role of outside science content consultants. The afterschool case saw very little involvement of scientists in program development. In large part, this was because the center decided to utilize an established university-based outreach group staffed by experienced science teachers and who were already developing and running educational programs. There were conversations around how to include cutting edge chemistry into programs, but, in the end, the experienced science teachers drew upon the kinds of content and approaches that they knew would work for the classroom-like settings in which they would be working. The center staff member tasked with running education and public outreach remained actively involved throughout the project, but the scientists were mostly disconnected from the work.

In the exhibit case, the scientist as consultant was more involved and the relation was prolonged, with scientists participating in multiple design meetings and, through extended exposure to the museum and its staff, learning about informal learning experiences in museums. Once the concept was developed, however, the museum took over design and production details for the interactive using their usual, well-developed processes. The scientists got a glimpse into the issues of designing informal experiences and grappled with the appropriate level and nature of cutting edge knowledge to communicate, but, in the end, it was the product that was the main focus. And once the product was completed and on the floor of the museum, the collaboration had run its course. From the perspective of the museum staff, the project represented minimal opportunities for learning and change. The effective use of content consultants and stakeholder co-design are well-established parts of an exhibit developer's typical repertoire of practice.

Informal educators train, scaffold, and support scientists who are involved in designing and delivering outreach mode. In the science club and media cases, the collaboration was structured to change the roles and relationships between educator, scientist, and audience. In the case of the club, especially, there was evidence of high levels of collaboration and learning across the university/informal boundary. Compared to the classroom-like settings of the afterschool case, the science club was small, neighborhood-based, and "owned" by local youth who dropped in for science activities. Building from an established trust with the youth, the club director systematically brokered the relationship between the university and the youth, having the scientists become a recurring presence in the club, getting to know the youth, iteratively co-designing activities, and traveling with the youth when they went on field-trips away from the club. This was a critical link between scientists and youth – and it is important to note that the link was built on the turf of the youth as opposed to the scientists. Getting out of the university and into the community is essential for the kind of deep and extended impact to which this project aspired. The scientists took on the role of instructors and mentors to an organized group of underrepresented urban youth who had, by being part of the club, already identified themselves as looking for deeper engagement with science. It would have been very difficult for university-based scientists to effectively reach such an audience without leveraging existing structures like the club.

The media case also provided opportunity for learning and boundary crossing, but focused more directly on skill building in the scientists. The collaboration was structured around broad science communication goals, with the producer providing training for scientists in communicating with public audiences through the collaborative development of the audio spots. Reflecting their prior experience working with public audiences and collaborating with artists and producers, the center leadership approached the collaboration with an open-ended and experimental stance. Both the producer and the scientists saw this opportunity as being about more than simply producing the specific content, and looked for opportunities to leverage the relationship for mutual benefit. In terms of the content, the media case provided some of the strongest examples of effective informal learning experiences focused on a center's complex and cutting edge science.

Collaborative professional development model. Aspects of the media and youth club cases reflect a move from training towards collaboration. The last case, the professional development case is a strong example of a deliberate effort to build a new collaborative relationship. Processes of working together with an audience in view were always in first position for this project, and both scientists and educators judged success primarily on what they were learning as they worked together. Museum staff learned about the science, and scientists learned about educational techniques and practices, and they jointly utilized these skills in prototyping educational experiences for museum audiences. In this case, both the museum and the center were experienced collaborators, and had staff on hand who could guide the project through some of the common pitfalls of working across the university/informal boundary. The desire to parlay the seed funding into a larger relationship echoed larger organizational strategies for both the museum and center—we were told in interviews of a regionally shared value for collaboration and how, at the local and state level, collaborative connections between universities, nonprofits, and for-profits were being actively encouraged and supported. In terms of sustainability, the museum fellows program emerged as an important outcome for the project, and provided a mechanism to incorporate informal education experience into the graduate and postdoc training programs.

Considering Success

So in which of these cases did the funder's investment in collaboration and innovation pay off? The diversity of approaches taken in the project makes it difficult to talk about success and impact in single way; in many ways success depends on our own vantage point. For example, from the perspective of the larger informal learning field and the funder, we might tend to prioritize dimensions that highlight innovative practice that could be shared and scaled with other informal educators. The funder might also place great value on the number and diversity of audiences served with these initiatives. From the perspective of the centers themselves, we might place value on the utility and sustainability of these specific partnerships. From the perspective of larger communities of scientists interested in broader impacts, success might be defined as lessons learned about the value of having scientists interact directly with public audiences, the institutional barriers and supports for scientists becoming involved in broader impacts, or the role of communicating cutting edge as opposed to general science in informal settings. Table 11.1 highlights a number of dimensions upon which these project activities could be measured. The columns can be seen as a continuum, but we caution that the continuum does not prescribe one particular ideal outcome. Rather we see this a matrix that one could use selecting a range point for each criteria that would result in a program that best suits the desired audience, science and budget.

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Boundary crossing. One metric of a successful collaboration might be to ask how many people moved across the university/informal boundary, and what parts of the project did those people represent? The logic here would be that supporting more boundary crossers would help to create a more broadly shared knowledge in an organization, make the partnership more resilient to personnel turnover, and increase the potential for innovative and sustainable collaboration (Russell, Knutson, & Crowley, 2013). By this metric, the media and professional development cases are particular standouts, with the ongoing collaborative activities bringing together relatively larger numbers of individuals from across different parts of the centers. In contrast, the crisp hand-off model of the afterschool partnership effectively isolated any potential organizational learning and change in the experience of a very few people.

Professional learning. Beyond number of boundary crossers, one might also ask what people did when they crossed a boundary and then what they took with them when they moved back across to their home context. This metric would favor particularly the science club case, as the scientists who developed modules for the youth were working for prolonged periods in new roles that were far beyond the typical comfort zone of a university-based researcher. The exhibit, media, and professional development examples also would be successful by this metric, as they all involved moments when scientists crossed over to do the work of informal educators to varying degrees.

Numbers served and efficiency. The projects illustrate trade-offs in how they positioned impact to themselves vs. their public audiences. The two hand-off projects opted for well-understood genres of work in well-established settings that already had built-in audiences. The projects were inherently low risk, and best described as one-way, transactional, and business as usual, with resources and specific chemistry content flowing from the center, to the be packaged by the informal educators, to be delivered to a large-as-possible audience. From that standpoint, both of these projects were successful. The afterschool curricula reached many groups of students and the museum exhibit continues to reach thousands of visitors. The products of each of these projects could be fairly easily “shrink-wrapped” and sent to other similar settings for immediate use, increasing their potential impact even further.

Institutional change. Center staff reported a positive impact of the informal education experience on their perceptions of outreach and their desire to be involved in this kind of work in the future. However, we saw more limited change in the ability of centers to support outreach in a new way. In many interviews, staff lamented the fact that they had more ideas for what they might do, if they had had more money or time, but the end of the grant would effectively end their ability to work together. Given that these projects were relatively short-term and created for the grant, there were always potential threats for sustainability. Without a strong interpersonal connection between sites, or joint goal setting emerging from a project, it would be hard to sustain collaboration. Additionally, in cases where the collaboration was isolated in one or two key contact persons, there is always the threat of staff turnover. Indeed, three of the centers had significant members of the team leave the group before or near the end of the project. Collaborations that involved creating new institutional processes, shared goals, and involved larger numbers of staff have shown the strongest sustainable elements.

Innovation in informal learning and science communication. Dealing with content that is difficult to communicate was a common concern for all of the projects. The afterschool project team was initially interested in activities related to the content, but ultimately decided that the needs of the more formal structures of the afterschool classroom could not be met without shifting to simpler content. The media project was better able to communicate cutting-edge content, as their format is adult-oriented, but even so, found it hard to make visible some of the processes that their scientists work on. Some of the programs that were targeted for school aged children struggled to make new content that related to the center research mission, while others felt that their time was better spent addressing more general science topics, such as lab safety, or science inquiry skills—the “basics” that students might be thought to need for success in school-based science instruction.

Conclusion

Comparing these five cases of university/informal collaboration is revealing in terms of identifying features associated with innovation and potential sustainability. In some ways, all five collaborations might have been expected to be similar: after all, they were all initiated by large university-based research centers, they all shared similar levels of funding, they all had dedicated staff who were already working on educational outreach, and they all shared the same goals and reporting requirements of NSF funding. Despite these structural similarities, the form of the collaborations, the nature of the educational experiences developed, and the potential for sustainability turned out to be, as we have detailed above, quite varied.

We conclude by reflecting upon the future of university/informal collaborations, noting current barriers that will have to be overcome in order to achieve successful collaborative ventures. Institutional conditions often work directly against scientists getting involved in this kind of work. We heard in interviews of how the work is often not valued by the university system, and made possible only because of the funding. This is despite the fact that there are many scientists eager to participate: The projects we studied were generally able to identify scientists who were very keen and inspired by the work, but even they often acknowledged that this activity may be detracting from their core academic research. This was a particular concern of the graduate students and postdocs, who often told us that they hope to bring their new informal expertise with them and connect it to their jobs as university-based scientists. We will need to do more than expand a scientist's own knowledge and skill of informal learning to see that hope realized. We will need to transform universities and scientific research centers to support in ways that encourage continued exploration of science education and outreach by crossing the university/informal boundary.

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