CHAPTER 11

Science Shops and the U.S. Research University: A Path for Community-Engaged Scholarship and Disruption of the Power Dynamics of Knowledge Production

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Science shops are organizations that coordinate and execute community-engaged research by bringing together university-based scientists, students, and community-based organizations to facilitate research that responds to the needs and interests of diverse stakeholders (Hende & Jørgensen, 2001; Martin, 2001). Science shops provide university students with unique opportunities to apply classroom-based learning to address community needs. Simultaneously, science shops offer spaces for non-university members to engage with the scientific research enterprise (Jørgensen, 2003).

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In this chapter, we propose that by facilitating collaborations between students, faculty, and community members, the science shop model can foster a culture of critical civic engagement and disrupt the power dynamics of "expertise" inherent in traditional models of scientific research. A science shop that fully incorporates principled engagement with communities in equitable research partnerships could make important strides towards reshaping academic scientific culture and disrupting problematic power dynamics in traditional modes of knowledge production. This approach can be particularly valuable for communities that have often been the object of academic study but have been largely excluded from the production of academic knowledge. The environmentally focused science shop established at the University of California, Berkeley in 2013 serves as a case study in the movement to democratize scientific practices and facilitate engagement between communities, students, and academics. This chapter presents this case study as both a documentation of one initiative within a public research university and a call to increase the study of—and institutional support for—such non-traditional forms of institutionalizing collaborative science.

The Politics of Knowledge Production and Representation at Universities

In an era of divestment from higher education, public universities in the USA are struggling to demonstrate their value to the public in both producing new knowledge that addresses pressing societal problems and educating an engaged citizenry (Fitzgerald, Bruns, Sonka, Furco, & Swanson, 2012). However, by not critically engaging with the assumptions and persistent paradigms inherent to the ways in which knowledge is produced within academia, universities reinforce unequal power dynamics that privilege expert knowledge and serve to further isolate knowledge production in the ivory tower. In the traditional model, "experts" conduct research on subjects in a top-down process. Experiential knowledge and knowledge held by non-experts (i.e., non-academics), including the subjects of study, are often dismissed and portrayed as biased and unreliable (Harding, 1993). The result is the silencing of non-academic perspectives, leaving communities "disempowered and unable to recognize their own expertise in the problems facing their community" (Assil, Kim, & Waheed, 2013,

p. 6). For communities that have historically been underrepresented in academic and political decision-making spheres, such as low-income communities and people of color, such disempowerment is particularly problematic because it limits their representation, diminishes their political voice, and can result in decisions being made, or solutions proposed, using scientific or policy narratives that might not reflect knowledge and realities on the ground. Even when these communities will be the ones most affected by the research and the resulting policies, their voices are typically marginalized (Assil et al., 2013).

Science shops as a movement arose in response to concerns raised by the popular education and participatory action research movements, science studies scholars, and education theorists about the politics and unequal power relationships in the ways in which knowledge is produced at universities. In the 1970s graduate students at the University of Utrecht devised a solution to fill the gap they perceived between academics and the local community. They started with a cardboard box for scientific questions from the community, which were answered by students and faculty. Their efforts led to the creation of an organization within the University that translated community research questions into projects that undergraduate and graduate students carried out. In so doing, they offered non-profits, small businesses, and local governments free or low-cost access to scientific research (Jørgensen, 2003).

Since then, science shops have become institutionalized in universities across Europe. They have played a key role in counteracting widespread sentiment that "scientific research is aimed at abstract knowledge or profit and not sufficiently geared towards the needs and concerns of society" (European Commission, 2003, p. 3). Transforming the academic scientific research enterprise to disrupt traditional hierarchical modes of knowledge production requires fundamental changes in the distribution of resources, intellectual representation and practice, and scientific culture around accessibility and expertise. Central to such issues is a re-imagining and re-working of the relationships between researchers and communities, and the practice of community-engaged scholarship in which community members are equal partners in the research enterprise. Science shops are one model by which universities can take on this challenge and work to democratize their process of scientific knowledge production.

Benefits of Science Shops to Multiple Stakeholders

Today science shops constitute an international network that, at least in Europe, has difficulty satisfying demand (Leydesdorff & Ward, 2005); however, there has been limited growth of these entities in the U.S. in part due to deficient funding support. Although the benefits and importance of institutional intermediaries like science shops is well recognized within fields such as public health (Ward, House, & Hamer, 2009), the model remains underutilized as a strategy for promoting and enhancing participatory research in multiple disciplines. The benefits of the science shop approach for community partners, students, and universities have been well documented and are outlined below (Jørgensen, 2003).

Benefits to Community Partners

For communities, science shops provide access to scientific resources and knowledge and give communities a place in setting the research agenda of universities. The present structure of academic research offers limited opportunities to incorporate, let alone *center*, community needs and interests in the formulation of research questions and methods, or the interpretation of research findings (Arimoto & Sato, 2012; Corburn, 2007). Community-engaged scholarship is often undervalued in multiple ways. Scholars of higher education have pointed to a culture in academic science that lacks respect for community knowledge and views community members not as collaborators but as objects of study. This results in researchers being reluctant to become involved in community partnerships, while those who do pursue community collaborations encounter both a scarcity of mentorship and a dearth of funding, grants, and acknowledgement for such work (Ahmed, Beck, Maurana, & Newton, 2004; Buys & Bursnall, 2007). Similarly, scientific publications, as the main product of most research, are in most cases not easily accessible to groups outside of academic circles and are often difficult to interpret and apply in a community context. As groups work to address issues in their community—such as the regulation of wastewater treatment or identification of point-source pollution—they develop hypotheses that require collaborative research. Scientific research, in turn, can help communities identify solutions and actions to tackle local issues, and often help bolster the legitimacy of community claims in political and other public discourse.

Science shops have proven successful in institutionalizing an entry point for community access to the university because they have the potential to build and hold *long-term*, principled relationships with community partners that may outlast one particular collaboration, semester-long course, or student thesis, and help facilitate collaborations with scholars from multiple disciplines. In so doing, they are better poised to respond to the interdisciplinary nature in which many communities define problems and research needs, and allow for research relationships to evolve beyond the confines of the academic calendar on a timeline that better responds to community needs.

Benefits to Students

Many university students view science as a tool that allows them to advance the frontiers of human knowledge while having a positive impact on society. University science curricula often posit research experience as a fundamental educational activity and encourage students to cultivate research skills; however, most undergraduate research programs privilege on-campus research in the library or laboratory, while community-based work is relegated to secondary status as public service. Opportunities for students to interact with communities are typically limited to service-learning or community-engaged courses, internships, or volunteer opportunities. Although these structures provide valuable services to community partners and experiential learning opportunities for students, they are not exclusively oriented around the production of new knowledge and rarely receive equal recognition as research experiences that start and end in the academy. Moreover, service-learning courses are constrained by the academic calendar and the subject matter of the course, making it difficult to investigate questions that require longer-term engagement and interdisciplinary methods. Through institutionalization science shop can bring recognition of the value of community-engaged scholarship to the academic enterprise and elevate and validate this type of collaborative knowledge production.

Science shops are uniquely positioned to implement opportunities for students to engage in hands-on research opportunities in collaboration with community-based partners. Project-based research allows students to apply classroom learning in a community setting where they engage with problems of everyday importance and local relevance, ask and refine

questions, develop and revise study designs, and interpret results (Schneider, Krajcik, Marx, & Soloway, 2002). Collaborative strategies can engender a sense of agency in the research experience (for both students and community members) and the development of principled social relationships. Project-based research also supports the development of non-traditional scientific alliances and demonstrates ways of doing science that are more inclusive of diverse values, beliefs, priorities, and job options. Science shops can expand students' basic conceptions of "what it means to learn and practice science" (Gallagher & Hogan, 2000, p. 108) and connect students with science in personal and meaningful ways. These opportunities also provide a venue for students to develop professional skills, contacts, and experiences that can lead to job opportunities (Jørgensen, 2003). Science shops also hold promise as a tool for attracting, retaining, and supporting students from underrepresented backgrounds in science. Anecdotal evidence suggests that educational opportunities that allow students to apply what they learn in the classroom to address real world challenges in underserved communities and give back to their own families and communities are particularly important in attracting and retaining students from underrepresented backgrounds to White male dominated fields such as engineering (National Academy of Sciences, 2011; Nilsson, 2015). At the same time, by modeling accountable science in which community partners are involved as equals in the research process, science shops can help to dismantle the culture of exclusivity and alienation that devalues diversity and plagues science education. When students find education to be empowering and transformative, they are likely to embrace and further investigate what they are learning (Bouillion & Gomez, 2001). Thus, by fomenting accountable science through principled community engagement, science shop scientific research experiences can connect with how students envision their own futures or open them to ones they had not considered.

Benefits to the University

Community-engaged scholarship brings many instrumental benefits to the research enterprise, such as raising novel research questions, facilitating access to data, and helping with study recruitment and retention. Balazs and Morello-Frosch (2013) have described the ways in which

community-engaged scholarship can benefit the scientific enterprise by improving its methodological rigor as well as public relevance and policy reach. In particular, relevance "refers to whether science is asking the right questions" while policy reach increasing the "degree to which knowledge is disseminated to diverse audiences and translated into useful tools for the scientific, regulatory, policy, and lay arenas" (Balazs & Morello-Frosch, 2013, p. 2). A community voice in the research process helps ensure both that the question truly reflects the problem and that the question is framed and addressed in a way that is congruent with the realities in which the solution will develop. Validating and institutionalizing these practices counteracts a long-held notion that scientists must occupy a position of detached, objective expertise, as disinterested and unbiased in the production of generalizable findings using cutting-edge questions. Facilitating and increasing the number of community-based research partnerships can start to deconstruct a concept of rigorous scientific work that excludes the kind of applied, context-specific research questions that preoccupy communities, and assumes that the involvement of "non-experts" in research necessarily leads to bias. As such, faculty and institutional leaders historically consider community engagement as service work *separate from* the types of knowledge production evaluated in promotion and tenure processes (Gelmon, Jordan, & Seifer, 2013). The best practices of community engagement such as incorporating lived experience, sharing decision-making, and spending large amounts of time on relationship development within the community have historically been viewed as compromising scientific practices. Oftentimes, the products of these partnerships are questioned for their rigor and impact. What is recognizable as peer-reviewed publications often discounts formats that have value in the community, such as websites, memos, policy analyses, and documentaries, thus impacting promotion and tenure processes for researchers who center community questions and relationships in their work. The proliferation of science shops can contribute to the change of these structures and increased opportunities for faculty interested in this type of work.

Science shops can further serve universities by acting as incubators for novel interdisciplinary research (as community-defined research problems rarely fall within disciplinary boundaries) while contributing to the societal mission of the university and increasing community visibility and understanding of the scientific process (Jørgensen, 2003).

The University of California, Berkeley Science Shop

The University of California, Berkeley Science Shop (hereafter "the Science Shop") was a generator of interdisciplinary research questions with applications beyond the academy (Andrade et al., 2014) built on the foundational understanding that local and regional twenty-first century environmental issues—climate change, energy use, and water quality—pose interdisciplinary problems for both impacted communities and scientists. Students led the visioning of the Science Shop but worked closely with faculty and community partners to develop a model. Together, we all envisioned the Science Shop as an institutionalized, visible, and publicly accessible space for non-academic groups to engage with university student and faculty researchers. The mission of the Science Shop was to provide community groups with free or low-cost access to research. A core commitment under this mission was that Science Shop research began with a problem or question identified by a community group outside of the University. Such groups included non-profits, local government, very small businesses, or other small civil society initiatives organized around a particular environmental issue (broadly defined). This specific environmental focus of this Science Shop leveraged existing professional strengths as well as the academic departments with whom we collaborated.

Each research question was refined though an iterative, bidirectional process core to the vision and working of the Science Shop (Fig. 11.1). While traditional undergraduate research programs focus on faculty mentorship in the formulation of student research questions, they often neglect—or entirely omit—stakeholders' roles in knowledge production and student interaction with them. To fill this gap, students working with the Science Shop were trained in the principles of community-engaged scholarship, and they themselves became active agents in formulating the research question, thereby challenging the notion of community knowledge and experience as secondary. Faculty were involved mostly as advisors, but the vast majority of the research labor and mentoring was conducted by students. In foregrounding community expertise and collaborative research design, the Science Shop *explicitly* aimed to disrupt the traditional dichotomy between "academic experts" and "community clients," a power-laden relationship that is often perpetuated by university-based centers offering similar research services or community-based internship opportunities to students. Undergraduate students could participate in one of two roles, either carrying out the research project or as

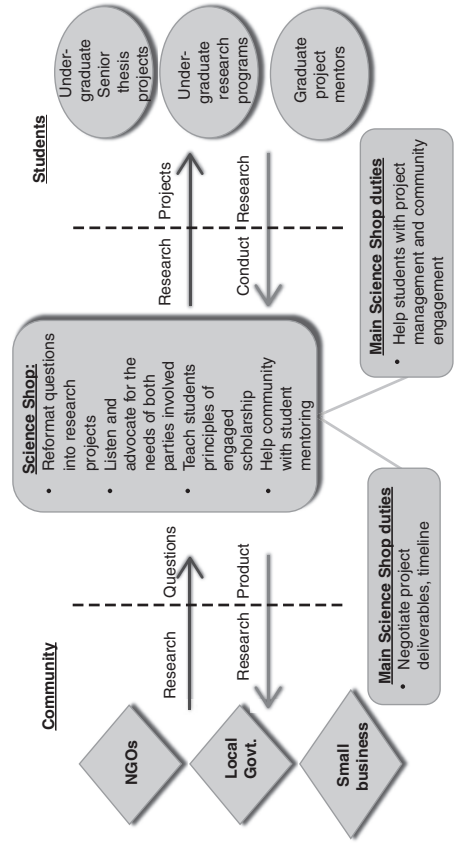

Fig. 11.1 Roles and processes of the UCB Science Shop

part of an administrative group that ran the Science Shop. In this model, graduate students were involved as technical mentors for the pilot projects, or in management and fundraising roles.

The Science Shop also facilitated community engagement by providing access to the practice and products of research at the University of California, Berkeley for free or at a low cost. This decision was a conscious effort to make the Science Shop an opportunity where financial limitations were not an impediment to having a voice in the research agenda of the University. The funding structure was possible because of several fundraising efforts undertaken by the Science Shop's student directors and the administrative and fundraising teams. Maintenance funds for projects came through this and other small internal grants and by working with existing University programs such as the Sponsored Programs for Undergraduate Research (SPUR) and the Undergraduate Research Apprentice Program (URAP). Regardless of these efforts and collaborations, the Science Shop discontinued operations in 2016 due to a lack of funding for full-time management staff.

Finally, we developed policies on data sharing and research methods design to model community engagement practices. Figure 11.2 illustrates the structural organization and procedural flow of the Science Shop. Researchers emailed partners on a weekly or biweekly basis with project updates, involved partners in experimental design and execution, and ensured that partners had equal access to data and primary materials. All students were required to present a formal report back to the community partner, the majority of which consisted of in-person presentations in addition to sharing final data and written analysis. In several cases, students continued working with partners after the completion of the initial project, including participating in follow-up research and contributing to additional reports.

The Salmon Creek Watershed: Land Use and Salmonoid Populations

The Science Shop received eight pilot projects from community groups and selected three for completion during 2013–2015. Projects were chosen based on the convergence of readiness of the project, availability of a student researcher with matching skills and interests, and availability or interest from a graduate mentor. One out of the three completed pilot projects is described below, with particular attention to the shared power of the community partner and researchers in co-creating the project, the

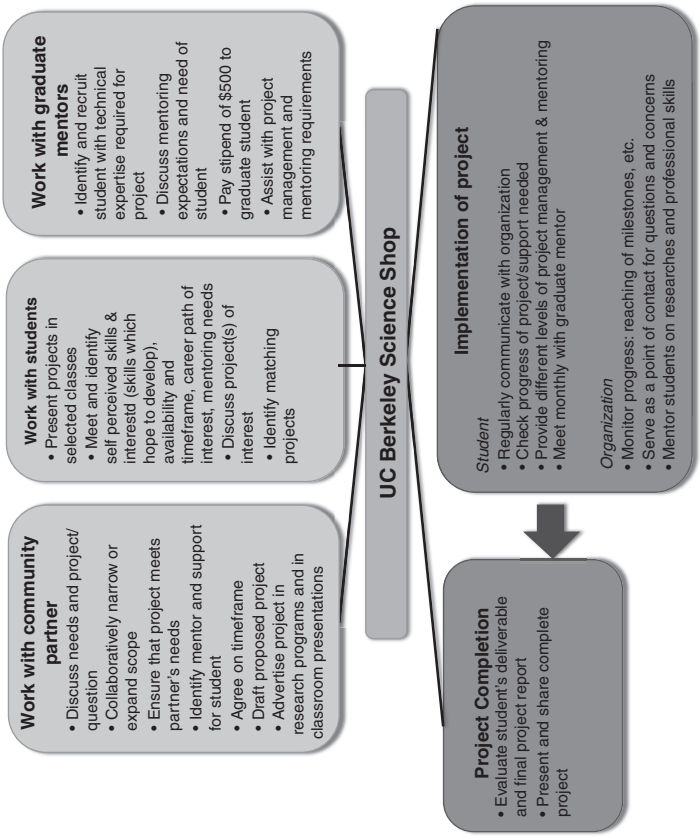

Fig. 11.2 Functioning of the UCB Science Shop

social change that resulted from the new knowledge that was created, and the role the project played in fostering a sense of belonging in science for a student from an underrepresented background. This project was selected for this volume because of the role this experience played in shaping the student's personal relationship and commitment to social justice work.

The Salmon Creek Watershed Pilot was a six month project developed with the community partner the Salmon Creek Watershed Council (the Council). The project used historical maps to assess land use changes in the Salmon Creek watershed (Sonoma, CA) and estimate the relationship between such changes and the decline in salmonoid populations. The Council is an "informal group of watershed residents and organizations committed to a collaborative, action-oriented process to conserve and enhance the unique natural resources within the Salmon Creek watershed" (Salmon Creek Watershed Council, 2016, para. 1). They were established in the mid-1990s when residents witnessed the sudden disappearance of wild Coho salmon in Salmon Creek due to a population crash, the causes of which are unknown. This loss was deeply felt by the community as an affront to their identity and sense of place, and mobilized residents to seek answers about what caused the disappearance and how the remaining salmonoid species could be protected.

Prior to the Salmon Creek project, the Council had a long-standing relationship with a University of California, Berkeley graduate student, and it was this student who approached the Science Shop with a project seeking to increase the Council's network at UC Berkeley. He also hoped the project would help them establish a permanent institutional relationship with the University, such that they could maintain access to the University's scientific resources upon his departure from the University of California, Berkeley. The student had worked with them to identify practices, such as rain catchment systems, that could help decrease water demand on the watershed from residents. These projects were based on the understanding that decreased water in the creeks harms salmon habitat. Most of the Council's efforts are focused on obtaining educational materials and evidence that can build their case for a more restricted use of water from Salmon Creek, a proposal that is locally contentious and inherently political in a state with a complicated history with respect to water rights. As a grassroots initiative of local residents in a watershed where 95% of the land is privately owned (Gonzalez, 2015), the Council must rely on community organizing and gathering allies to help promote their priorities and create

social change. Academic partners that can provide scientific evidence to inform their strategies and messages are one key asset in this work.

The Salmon Creek pilot project was selected through an open meeting with the Council members, community, Science Shop staff, and a student researcher. This meeting was a crucial component of the project design in that it served as a venue for Council members to present and deliberate their interests and priorities with the Science Shop and researchers. The Science Shop provided feedback on each of the Council's research questions, and suggested which one was best suited for a project of the correct timeline, scope, and technical difficulty for an undergraduate student. Science Shop staff and the student refined the question *together with* the Council and designed a final project that aimed to document changes in parcel divisions and residential water demand throughout approximately 35.3 square miles of the Salmon Creek watershed using historical maps from 1863–2014 housed at the University of California, Berkeley library. Decision-making power about the objectives, methods, and deliverables of the project was explicitly shared, with the Council taking the lead on defining the research question and translating the findings into action and the UC Berkeley team leading the analysis and contributing the human, technical, and archival resources (maps). In this way, the project embodied a model of shared power in setting the research agenda.

Using the expertise of local residents and historical research, the student working on this project selected two time periods that reflected different water use types, from 1863 to 1934 and from 1934 to 2014. These periods were chosen as approximate dates marking the before and after the widespread availability of water-intensive appliances and landscape irrigation (Gonzalez, 2015). She estimated that residential water demand proportionally tracked the growth of parcels between these two time periods and was able to describe how that increased development of the land strained water availability for creek wildlife (Gonzalez, 2015). The findings supported the local efforts of the Council to increase the number of rain catchment systems on private lands in the watershed by validating their assertion that reductions on residential water demand from the creeks were needed to protect salmon. These results were leveraged by the Council to gain support for their efforts through a community meeting at which the student presented her results. Graphical displays and historical maps were used to make the information more relatable to local residents and help build a sense of belonging and responsibility for the watershed

among participants. All research products were made accessible to the Council for future use in their organizing and education efforts. The event was well attended and covered by local media outlets and the student continued to work closely with Council members after graduating in 2014. Together, they produced a report on the findings from the pilot that was circulated in local press and on the Council's webpage.

The undergraduate student who led the research on this pilot was Mexican-American and came from a low-income, farm-working community in California's Salinas Valley. She was a graduating senior with substantial research experience in fish and aquatic ecology; however, she came to the Science Shop out of disappointment with the lack of opportunities to connect her research with community concerns. She described not feeling a sense of belonging in science due to the disconnect between her experience with research and her drive to contribute to social change. The Science Shop project introduced her to community-engaged scholarship and pushed her to learn skills that she had not developed in her laboratory or field experience, such as using maps for historical ecological research, writing reports collaboratively with community, and presenting information to a non-academic audience. This experience "connected the dots" for her and helped her see that her scientific skills did not need to feel separate from her desire to "give back." In this way, the Science Shop helped create a home within academia for the student in which she could envision herself as an activist scientist capable of challenging the traditional top-down notion of what it means to do science.

The student credits her work with the Science Shop as key to developing a commitment to community-engaged research. When she contrasts the lessons she learned from the Salmon Creek project to other research experiences, she reflects that the project taught her the importance of strong, trusting community relationships in advancing social change. Through practice it showed her that social change is slow and taught her the importance of carefully building a network of allies to champion challenging social and environmental justice initiatives. She currently works as a science elementary school mentor after having worked for several years for a non-profit that addresses issues of environmental justice, water quality, and access in her home region, California's Central Valley. She is carefully considering her next steps, and plans to return to graduate school once she settles on a specialization that will help her be a more effective change agent.

Conclusion

While much scientific research conducted in U.S. research universities is publicly funded, non-academics tend to have a minimal role in setting the research agenda. Science shops such as the one that existed at the University of California, Berkeley hold much potential to fill this gap. Science shops can be used to cultivate undergraduates' sense of civic responsibility by helping to legitimize community engagement within the academy. They also increase access to scientific knowledge and the capacity to create it among students *and* communities. Furthermore, engaging undergraduate students in experiential, project-based learning to address community-identified research needs can foster new models of knowledge production that empower communities as equal partners in the research process and increase student engagement in both social change and the scientific enterprise. Fostering science shops at U.S. research universities could help cultivate university-community partnerships that co-create action-oriented research poised to bring about social change. This type of initiative simultaneously enhances the abilities of students to recognize their agency in forging collaborative scholarship that disrupts the traditional power dynamics of knowledge production.

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