Establishing Partnerships for Science Outreach Inside and Outside the Undergraduate Classroom

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STEM outreach experiences provide aspiring scientists and healthcare professionals with opportunities to grow into new roles, integrate knowledge, and acquire soft skills. While STEM outreach publications often describe the outreach performed, few focus on how to establish strong partnerships, which are essential for outreach endeavors to succeed. Information on this is more important than ever before—grant agencies commonly require education and outreach plans that will reach a broader audience. Consequently, principal investigators who are not trained in education or outreach need tools to set up strong partnerships. To help fill this gap, here we outline the recommended steps for developing robust interdisciplinary STEM outreach programs that leverage institutional resources and community partnerships. This process yields strategic and sustainable opportunities for undergraduate students to learn as they engage with the STEM outreach team (students, faculty, university staff, and community partners) and the lay public. The outlined ideas broadly apply to creating outreach programs for trainees at any stage, not just undergraduates.

INTRODUCTION

Outreach experiences provide future scientists and healthcare professionals with opportunities to teach, mentor, and communicate with the lay public (1–4). Students can apply their knowledge and acquire soft skills, like adaptability and self-confidence, to prepare them for new roles (5–8). Participating in STEM outreach can help students offset a lack of formal coursework in areas like teaching and science communication. Because outreach activities build student knowledge and confidence while linking participants with like-minded peers, these experiences can help students shape their science identity (9–14). Broadly, public outreach allows undergraduates to develop an understanding of how to engage individuals from different backgrounds and experiences (15).

There is currently a gap in the STEM outreach literature: many articles describe the outreach performed, but few speak on establishing strong outreach partnerships. This is unfortunate, because strong partnerships are key to successful and sustainable outreach efforts. In fact, Wojnowski recognized that the most successful programs were “more about people than about collections or artifacts” (16). If the focus on people is essential, then successful outreach requires insight into how these partnerships are established and structured so that it benefits all participants—students, partnering institutions, faculty, and community members.

Most grant agencies now require sustainable education and outreach plans that reach a broad audience, maximize resources, and provide a substantive impact for all involved stakeholders: educators, students, and the public. Consequently, principal investigators must know how to establish strategic partnerships that will improve public science literacy and support student science communication skills (17).

STEPS FOR ESTABLISHING STRONG PARTNERSHIPS

Here we outline seven practical and easy steps for establishing strong partnerships once a STEM outreach project of interest has been selected. These principles helped us implement robust outreach partnerships both inside and outside the undergraduate classroom at High Point University (HPU). Using these principles, we developed a variety of opportunities, such as full-day STEM
workshops using LEGO educational resources (http://www.highpoint.edu/education/legoshowcase/), a full night of space-themed experiments and demonstrations (www.highpoint.edu/planetarium/event/hpuniverse-day/), use of a mobile lab to take science into the community (http://www.highpoint.edu/community/mobilelab/), and incorporating service learning (http://www.highpoint.edu/servicelearning/) into the college classroom curriculum. To illustrate the utility of these steps, we describe how they were used in the implementation of two of these outreach opportunities—the creation of the HPU Mobile Lab and a Service Learning Cell Biology course (Table 1).

Step 1: Develop your outreach activity goals

Just as an educator develops a set of learning goals at the beginning of a course, it is important to develop objectives for the outreach activity or program. This helps define the outreach and guides community partner selections and outreach event planning. The outreach goals may be short-term, such as a single science day at a local elementary school, or longer term (Table 1). For example, the creation of the HPU Mobile Lab was inspired by the desire of faculty members in the sciences to reach out to underserved and underrepresented community members in the city of High Point, NC (Table 1). Once this goal was realized, partnerships across disciplines and offices on campus arose to allow the mobile lab to be developed (Table 1).

Step 2: Don’t go it alone—leverage in-house resources to find community partners

Determine the existing offices or programs at your academic institution that can provide helpful resources for the implementation of your STEM outreach project. This can be accomplished digitally or through conversations and recommendations. Meeting with administrators from broad areas, such as natural sciences, education, health science, and service and experiential learning, can provide contacts and outreach opportunities on campus and in the broader community. The relevant information about the outreach project, including its objectives, can be a highly effective communication tool during these meetings and discussions.

Communicating with in-house departments such as the Office of Communications, Office of Community Relations, or individuals who have served as community liaisons can help you identify a potential community collaborator. The degree to which institutions support centralized resources for community engagement varies greatly; it can range from no institutional support to multiple dedicated offices. For example, many well-funded or large state-supported institutions have offices dedicated to outreach and civic interests off campus, while smaller institutions or those facing budget constraints may lack resources to support community engagement programming. Even if that is the case, faculty, undergraduates, and administrative staff can self-organize to advance their outreach initiatives.

At our institution, we have several offices or committees dedicated to facilitating community engagement. The following are three examples of instances when we have collaborated with these offices to help strengthen the development of our outreach programs. First, the HPU Mobile Lab has worked with the Office of Communications at the university to document events through photography and video, advertise outreach events on social media, and maintain a webpage that community members can reach out to for information (Table 1). Second, our campus Service Learning office works with us to determine whether insurance coverage issues and/or background checks (especially when working with community partners in the public school system) need to be considered (Table 1). Third, our Institutional Review Board (IRB) representatives orient us and provide assistance when identifying the need for IRB protocol approval for service learning courses (Table 1).

If your institution lacks outreach support, you can consider a broad range of alternatives, such as local schools, community events, or outlets like farmers’ markets. Governmental agencies such as Parks and Recreation offices and local libraries, along with nonprofit organizations such as science or children’s museums and zoos, are additional terrific resources. There is also the possibility of forming partnerships within the academic institution (and/or multiple community partners), catalyzing the coming together of different programs and their students and personnel, to host interdisciplinary outreach events. Another alternative is academic institutions hosting events as part of their state’s or city’s science festival. Potentially large and high-profile outreach activities like science festival events often benefit from campus partnerships to host the event. We discuss engaging multiple programs and campus entities later in this article as a way to strengthen the impact of outreach and expand its reach.

Step 3: Connect with a potential community partner

Once potential community partners are identified, connect with them by setting up an in-person meeting to discuss the potential collaboration. During these meetings and discussions, share relevant information about the outreach event, including the desired outreach objectives. Because the outreach event must benefit all partners, it is important to tweak outreach goals so that they fit the community partner’s needs. The partnership will not be sustainable if your outreach objectives fail to sync with your community partner’s missions and goals.

We have found that in addition to mission alignment, strong partnerships also require that each collaborator feels equally valuable to the effort. Consistent, open, clear, and respectful communication among all partners is essential. An agreement of mutual benefits and responsibilities, often referred to as a Memorandum of Understanding (MOU),
### TABLE 1.
Two examples that highlight the implementation of the recommended steps for iterative and sustainable STEM outreach.

| Recommended Step                                      | Case Study Examples |
|--------------------------------------------------------|---------------------|
|                                                        | **Mobile Lab**      | **Service Learning Cell Biology** |
| 1. Develop outreach goals                              | To provide a scaffold for undergraduate student engagement with community science outreach alongside opportunities to integrate knowledge learned in the classroom.  
- To provide local community members access to scientific knowledge and tools.  
- To foster interest in the sciences through scientific experimentation.  
- To discuss and give examples of the ways in which Cell Biology content can be differentiated for the lay public and communicated to them in engaging ways.  
- To integrate the course material to create and implement a science outreach module. |
| 2. Explore institutional resources                      | Offices of Service Learning, Communications and Community Engagement, Transportation Dept., School of Education  
Office of Service Learning, IRB, School of Education |
| 3. Connect to community partner                         | A website was established for the Mobile Lab Program. Potential community partners could request to collaborate via a survey; community members provided essential information, such as audience, what they were hoping to accomplish with the collaboration, and any type of programming they already had in mind. With this information, the Mobile Lab representatives developed specific goals tailored to the collaboration and scheduled a meeting to further discuss with potential community partner.  
A nearby high school Biology class was selected, and a science teacher helped the college instructor ensure undergraduate outreach project topics matched the teacher’s lesson plans and state standards. High school class times and Cell Biology course laboratory times were selected so that they overlapped, enabling monthly visits from undergrads to the selected high school. |
| 4. Develop outreach partnership (Student Engagement Model) | Single event or sustained outreach can be implemented, depending on the needs of the community partner making the request.  
On a sustained basis (every month), undergraduate Cell Biology students visited the high school Biology class and implemented an outreach module they created on a preselected topic approved by the science teacher. |
| 5. Implement, assess, evaluate                         | Student volunteers are recruited using a survey. This allows for electronic collection of contact information and schedule availability, allowing future exchanges of information related to outreach experience logistics, content, and preparation. Volunteer orientation meetings and training sessions are scheduled as needed. After the event is complete, evaluation surveys are sent to both volunteers and participants to request feedback on what worked and what needs improvement.  
Students create, test, and implement outreach modules using course laboratory time and additional tools to prepare. Students complete reflection after outreach experiences as well as a course evaluation that targets service course components (see Table 2 for sample data) |
| 6. Debrief and iterate                                  | Volunteers and participants are sent a thank you e-mail that includes pictures from the event and salient common accomplishments. If dates for future iterations of the event are available, these are shared as well.  
Monthly course discussions focus on outreach periods including things that went as expected or challenges that were encountered. |
| 7. Strengthen and amplify (deepening student involvement) | Students from other schools on campus can be recruited for help with event planning and advertising (e.g., Entrepreneurship, Art and Design).  
Students can present their outreach modules during on-campus creative works or service showcases. |
can be helpful for this. An MOU should include the roles key individuals in the partnership will play.

An example of a partnership with complementary goals would be postsecondary programs that aim to provide experiential learning opportunities for their scientists-in-training in partnering with high schools seeking to expand access to collegiate-level science resources. A simpler example could be an undergraduate introductory level science course incorporating an outreach experience later in the semester, with students adapting material into activities for K–12 students who need broader exposure to experimental science than their school can provide.

**Step 4: Develop outreach partnerships based on outreach goals**

The engagement models described below can serve as a guide for your outreach program's structure. Your choice of model depends on your goals. Partnerships should provide both the target audience and undergraduate students assisting in the outreach the opportunity to help develop and implement outreach activities.

**Event engagement model.** In this model, undergraduate students engage in science outreach through community events organized by the home institution outside of any specific course.

**Sustained engagement model.** In this model, undergraduate students engage in sustained science outreach throughout the semester. This outreach may be a part of a student club or integrated into a course. Service learning is a pedagogical structure that allows outreach to take place through academic coursework while students are assessed and receive academic credit for their outreach (18–21). Student clubs can partner with community members for a semester-long experience, such as biweekly or monthly outreach events with local schools or after-school programs. Regardless of the context, the most successful events share a common feature—they are designed around a strong partnership between community and academic programs.

**Step 5: Outreach implementation, assessment, and evaluation**

Once the goals of an outreach program or event have been defined, volunteers are solicited from relevant student groups across campus. They can begin to perform literature searches related to the topic of the outreach and begin developing activities or experiments to meet the outreach goals. Based on the outreach event, volunteers should be introduced to pedagogical techniques, such as hands-on learning, model-based inquiry, storytelling, visual demonstrations, and problem- and project-based learning to increase program efficacy. As activities and outreach materials are designed, volunteers should also consider the target audience and minimize technical jargon that hinders participant engagement. Efforts should be made to document outreach to help secure future support.

Formative and summative assessment tools, such as surveys, are useful for determining whether the science outreach goals are being met. For large events with high attendance, assessment is often done by calculating the number of attendees who engaged with the planned activities and/or by asking selected participants a few key questions about their experience. In our experience, the sustained engagement model allows for more intricate assessment strategies since this model involves prolonged timelines and more sophisticated interaction dynamics. For example, in a formal service learning course where students are earning credit, a survey can be administered at the end of the course to gauge students’ perspectives and reflections on their community engagement and course experiences. Additionally, questions related to the service component can be periodically administered to understand how the service aspect of the course is progressing.

An ongoing formative reflection component can help faculty adjust the curriculum in real time, improve students’ communication and other soft skills, and help students understand their own implicit biases that may affect how they engage with others. Successful outreach programs result in students reporting outcomes such as increased interactions with individuals from different backgrounds, understanding challenges faced by the community, self-awareness, problem-solving skills, and confidence (22).

For an example of outcomes that can be attained, Table 2 contains end-of-course assessment information for the Service Learning Cell Biology course described as a case study in this article. No matter what assessment approach is used, assessment data should be goal-driven and used to improve and strengthen future program iterations.

The key partners that collaborate in hosting the event also play an important role in assessment. Through observation and survey results, partners can note areas of improvement during project implementation, and these notes can be revisited during debriefing.

**Step 6: Debrief and iterate**

Sharing program feedback and allowing time for reflection is essential. One way to do this is to create an assessment summary or report to share the partnership outcomes with all involved. This report can serve as a debrief conversation scaffold and it can be useful for directing program adjustments for future iterations.

**Step 7: Strengthen and amplify the outreach’s impact and expand its reach**

Engaging multiple departments and offices across campus can strengthen and amplify the outreach program's impact. For example, undergraduate student volunteers can be strategically recruited from different departments,
courses, or student clubs related to the focus of the science outreach event (for example, natural sciences and pre-service STEM teachers). Depending on student preferences, individual students can deepen their involvement with the outreach by actively helping organize the science outreach event or taking the lead in the design of the activities, with guidance provided by faculty members. Furthermore, if they need funds to make an aspect of the event happen, students might want to take it a step further, generating a proposal and applying for available funds from the institution.

TABLE 2. Summary of Service Learning Cell Biology student perspectives on self and community.\(^a\)

| Prompt | % (No.) Who Strongly Disagree or Disagree | % (No.) Who Neither Agree nor Disagree | % (No.) Who Agree or Strongly Agree |
|--------|------------------------------------------|--------------------------------------|-----------------------------------|
| The service learning part of this course made an impact on my life that will last beyond this course. | — | — | 100% (12) |
| The service learning aspect of the course helped me see how the subject matter I learned can be applied in everyday life. | — | 17% (2) | 83% (10) |
| The service learning experience provided opportunities for me to interact with people from different cultural and socioeconomic backgrounds than my own. | — | 8% (1) | 92% (11) |
| I learned more in this class because it had a service learning component. | 8% (1) | 33% (4) | 58% (7) |
| The work in the community made me more aware of my biases and prejudices. | 17% (2) | 50% (6) | 33% (4) |
| The work in the community helped me develop problem-solving skills. | 8% (1) | — | 92% (11) |
| I understand the challenges facing the High Point community better because of this course. | — | 25% (3) | 75% (9) |
| The service learning experience helped me better identify complex ethical issues. | 25% (3) | 33% (4) | 42% (5) |
| The ideas of combining work in the community with a university course should be practiced in more courses at HPU. | — | 17% (2) | 83% (10) |
| I formed a closer relationship with my instructor than I would have in a class without a service learning. | — | 33% (4) | 67% (8) |
| This course made me feel a stronger personal responsibility to use my knowledge and skills to serve the community. | — | 17% (2) | 83% (10) |
| I feel the work I did in the community really benefited the community. | — | 17% (2) | 83% (10) |
| I feel I spent more time on this course than I do on equivalent level non-service learning courses. | — | 42% (5) | 58% (7) |
| I feel the time I spent on this course was worthwhile. | — | 25% (3) | 75% (9) |

\(^a\) Students enrolled in Service Learning Cell Biology in the spring semesters of 2017 and 2018 (\(N=12\)) were surveyed at the end of the course to gauge the impact of the science outreach component on their perceptions of self and community. For some prompts (rows), the values may not add up to 100 due to rounding.
or student government. Alternatively, there are scientific societies that have grant mechanisms to which student organizations can apply for outreach activity funding (https://www.ascb.org/grants-awards/compass-outreach-grants/; https://www.acs.org/content/acs/en/funding-and-awards/grants/chemclub-community-grant.html).

CONCLUSIONS

Effective and sustainable STEM outreach is founded on strong partnerships. We recommend that partnerships be established in the early stages of the outreach project. Early collaborations can help ensure program elements will work synergistically to help attain the desired outcomes.

ACKNOWLEDGMENTS

We thank our students, who are always eager to engage in service and outreach, as well as their community partners, including Tarsha Reid and her contributions to Penn Griffin School for the Arts and High Point Central High School. We also thank our colleagues Brad Barlow, Joe Blosser, Neil Coffield, Jackson T. Sparks, and Mariann Tillery, not only for their passion for outreach but also for their partnership in implementing our outreach programs and their helpful comments and contributions to this manuscript. Part of this work was funded by a High Point University Think BIG grant to V.A.S. and N. Coffield. The authors declare there are no conflicts of interest.

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