

Undergraduate Students Are the Key to Community Science Outreach Partnerships

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We summarize a community science outreach partnership between undergraduate students and rural K-12 teachers and students. The Biocore Outreach Ambassadors (BOA) are students in the University of Wisconsin-Madison Biology Core Curriculum (Biocore) program who volunteer their time to enrich rural K-12 science curriculum by introducing science activities aligned with Next Generation Science Standards (NGSS). The scientific approach that inspires BOA outreach activities is a natural extension of the authentic inquiry process that students experience in our integrated 4-semester honors curriculum. BOA outreach activities include classroom visits, Family Science Nights, After School Science Club, Children's Hospital visits, and a week-long Summer Science Camp. BOA students describe their volunteer experiences, community interactions and how they affect their own learning and attitudes toward science. The BOA advisor discusses the pedagogical and logistical support she provides to students, as well as the inherent mentorship challenges. Lessons learned and best practices are shared.

Keywords: science outreach, undergraduates, authentic inquiry process

Introduction

We describe here a unique partnership between rural K-12 schools and undergraduates at an R1 Midwestern university. K-12 school and university science outreach partnerships are targeted to benefit K-12 student learning and also provide powerful science role models for K-12 students. In a study of Oregon State University undergraduates who participated in rural K-12 outreach, Rao et al. (2007) concluded that, "*Partnerships with universities are critical for enriching learning experiences and for documenting to K-12 students, especially those in rural communities, that higher education is within their reach.*" University – K-12 partnerships also offer deeply valuable experiences for undergraduates in ways that we are just beginning to understand (Carpenter, 2015).

The University of Wisconsin-Madison Biocore Outreach Ambassador (BOA) Program is a K-12 rural school-university partnership model that ABLE partners could adapt for their own institution. We describe our outreach activities, challenges, rewards, key logistics, and lessons learned, from the perspective of both undergraduate students as well as the undergraduate instructor/outreach advisor.

BOA's Origin in the Wisconsin Idea

The Biocore Outreach Ambassadors are a group of undergraduate students in the University of Wisconsin-Madison honors Biocore Program who volunteer their time to do science outreach. The BOA program began in 2004 as a Wisconsin Idea Fellowship project implemented by two Biocore students who wished to share their passion for scientific exploration with the surrounding community. (The Wisconsin Idea, a philosophy that encourages the extension of the benefits of our UW System beyond the boundaries of our campus, has been a guiding principle behind UW-Madison community outreach for over 100 years; <http://www.wisc.edu/wisconsin-idea/>). For the past 13 years, BOA undergraduates have exemplified the Wisconsin Idea by serving as an educational bridge between UW-Madison and rural K-12 school districts.

BOA primarily focuses on rural schools because they are often underserved in terms of funding and access to our University's resources. BOA seeks to foster strong connections between the University and local communities while providing opportunities for K-12 students to authentically engage in science. BOA does not intend to replace K-12 science curriculum, but rather to enhance and compliment it. Our BOA mission statement reads:

Ambassadors work side by side with classroom teachers to enhance science education in rural Wisconsin communities

Outreach emphasizes process of science, NGSS

The pedagogies utilized by BOA undergraduates in their science outreach are inspired by their own experiences in our UW-Madison Biocore Program. Students in our multi-semester honors curriculum repeatedly engage in authentic inquiry processes in our integrated 4-semester honors curriculum. Biocore learning outcomes are well-aligned with the Core Competencies and Disciplinary Practices described in AAAS's Vision & Change in Undergraduate Education (2011). In particular, our students repeatedly practice independent research experimentation and effective communication skills as they progress through 2-3 semesters of our lab curriculum. (Batzli, 2005; see also Batzli et al. in this 2018 ABLE Proceedings). BOA volunteers then use their own process of science experience to encourage children to ask their own questions, and then examine any evidence to formulate explanations in order to understand a scientific problem.

The process of science approach that BOA undergraduates use in their outreach activities is also well-aligned with Next Generation Science Standards (NGSS; 2013). Many K-12 teachers and administrators have expressed to us their struggle with developing curriculum that is aligned with NGSS Performance Expectations, especially the Practices of Science and Engineering element. When BOA undergraduates facilitate activities that engage children in the process of scientific inquiry (*i.e.* the formulation of testable questions, hypotheses, experimentation, and rationale for biological processes, etc.), they are modeling to K-12 teachers how children can use authentic science practices to participate in the scientific process. Our goal is to empower our teacher partners to incorporate the process of science into their curriculum.

Outreach Activity Expansion

As the number of BOA undergraduate volunteers has grown from two students in 2004 to well over 40 students per year currently, our unique outreach efforts have greatly expanded (see Fig. 1). Each of the activities summarized below originated with BOA student suggestions, and became successful because of BOA student energy and dedication.

Classroom Visits

Two to three of our most experienced ambassadors visit the same elementary school classrooms bi-weekly to work alongside K-12 teachers to develop and implement authentic inquiry projects aligned with NGSS. BOA students mentor activities and projects that are driven by student questions.

After School Science Club

We have maintained a longstanding After School Science Club (ASSC) at an elementary school 25 miles northwest of our campus (Mazomanie Elementary School, in the Wisconsin Heights School District). Four to five ASSC ambassadors provide extracurricular science activities to elementary students two times each month during the school year. During each ASSC meeting, between 20-30 3rd-5th grade students have the opportunity to explore a different scientific concept using authentic process of science skills, culminating in mini poster presentations at the end of the school year.



Figure 1. Summary of main Biocore Outreach Ambassador (BOA) activities.

Family Science Nights

Two to three times each semester, 20-30 ambassadors travel to various schools within a 60-minute drive of our campus to engage students and their parents in various interactive, inquiry-based science activities during Family Science Nights. Activities include a multitude of experiments, ranging from exploring hypothesis formation using a Mentos and Diet Coke geyser to understanding principles of scientific methodology when extracting DNA from wheat germ, from the hands on manipulation of microscope slides to examining the evolutionary processes underlying form – function relationships, and beyond. We invite many other science outreach organizations from UW-Madison and the surrounding community, as well as University faculty members, to collaborate with us at Science Nights. Attendance at our Science Nights has ranged from 100-600 children, parents, and other family members.

Children's Hospital Visits

Two to four BOA volunteers make regular visits to patients in the American Family Children's Hospital located a few miles from our campus. Children staying at the hospital have the opportunity to get involved in science

based activities with the hope that they will become inspired and find their spirits uplifted.

Summer Science Camp

BOA members in conjunction with instructors from the Biocore program, the Biochemistry Department, and the UW-Wonders of Physics program work with the Wisconsin Heights School District to organize a week-long summer science camp. Students participating in camp range from 4th to 12th grade. These science campers learn about the process of science (asking testable questions, experimental design, *etc.*) through studying a scientific area of their interest. Campers work in small groups to investigate a question of their own choice, and are mentored by BOA members. By the end of the week, campers carry out an investigation, gather data, and present their research to their families and other campers via group poster presentations. Science Camp research topics have included Stream Ecology, Physics, Chemistry, Forest Ecology, Sports Performance, and Prairie Ecology.

Campus Outreach Events

BOA partners with various science outreach programs on campus including Science Expeditions (sponsored by the UW-Madison Science Alliance) and the Wisconsin Institute for Discovery's Wisconsin Science Festival, where we host science activity stations. The UW-Madison Zoology Museum frequently provides specimens for these various outreach events. BOA Female ambassadors partake in an annual event called Expanding Your Horizons which aims to inspire young female middle school students to pursue science careers.

Funding & Budget

The BOA outreach efforts described above cost ~\$4,000-\$5,000 each year and are supported entirely by grants. Previous BOA funders include the UW-Madison Wisconsin Idea Undergraduate Fellowships, UW-Madison BioTrek Program, UW-Madison Kemper K. Knapp Bequest Committee, the Capital Times Evjue Foundation, Inc., and private donations by community members. These grants have allowed the Biocore Outreach Ambassadors to offer most of our programs free of charge (Science Nights, Classroom Visits, and After School Science Club) or at minimal cost (Summer Science Camp). The largest BOA expense is the rental of university fleet vehicles to transport our volunteers to outreach events. Other expenses include consumable materials utilized in our inquiry-based activities and BOA t-shirts for our undergraduate volunteers.

The UW-Madison Biocore Program supports BOA through its in-kind contribution of staff time and recruitment of student volunteers. Biocore's Program Manager handles BOA budgetary, travel, insurance, and scheduling logistics. Biocore's Lab Manager assists ambassadors with equipment and supply needs, and is a

Summer Science Camp instructor. Finally, the Biocore Program has incorporated the BOA advisor role in the official job description of Faculty Associate MH.

BOA Leadership Model

The BOA advisor (MH) oversees the program, providing continuity for our community partners as well as undergraduates progressing through our 4-semester Biocore program. BOA advisor duties include weekly planning meetings with BOA co-chairs, initiating and maintaining contact with community partners, organizing/leading the Summer Science Camp, assisting with grant writing, and attending Science Nights twice per semester. Most importantly, the BOA advisor serves as a "quality control" check, ensuring that ambassadors appropriately and proudly represent our Biocore Program and the UW-Madison Wisconsin Idea.

BOA co-chairs are two to three senior students who have completed the Biocore Program, and who have also served as BOA co-chairs-elect for one year. The co-chairs organize and coordinate BOA outreach activities, maintaining regular contact with all BOA members through management of an email account. Co-chairs are responsible for all of the logistical planning for Science Nights and campus outreach events, train BOA volunteers to facilitate inquiry-based activities, mentor BOA co-chairs-elect, organize our BOA supply closet, and assist in oversight of all BOA activities.

BOA co-chairs-elect are two to three junior students who are completing their second year of Biocore coursework. Co-chairs-elect attend weekly meetings with the BOA advisor and co-chairs, and gradually assume the duties of the co-chairs over the school year. Finally, the After School Science Club, Children's Hospital, and Classroom Visits all have BOA leaders who are typically upper level students with extensive outreach experience. This model of a consistent advisor, veteran senior leaders, and mentored junior leaders has greatly contributed to our outreach program's consistency and continuity over the past 13 years.

Challenges & Benefits to Undergraduate Students

As with any volunteer program, utilizing active undergraduate Biocore students as volunteers has inherent challenges due to busy academic and extracurricular schedules (see Table 1). The growing number of undergraduate BOA members in our program, however, attests to the benefits that members gain from their outreach experience. Biocore Ambassadors experience personal growth as well as professional development through their work with the community. Ambassadors learn about responsibility, interpersonal communication, and professionalism while sharing their talents off campus.

Challenges & Benefits to Outreach Advisor

As the BOA program has expanded the number and frequency of its outreach activities, the time commitment required of the BOA advisor has grown proportionately. During a typical semester, BOA-related activities require ~2-3 hours each week, but this increases to ~7 hours per week when we offer Science Nights. During the month prior to Summer Science Camp, BOA-associated activities take 10-30 hours per week, and the entirety of Science Camp week. Table 1 summarizes the challenges, benefits, and time commitment experienced by those involved in our BOA mission.

Lessons Learned & Recommendations

The following lessons and recommendations stand out among the countless we have learned through the duration of our program:

1. Lesson: community partners do not want us to tell them what they need. Recommendation: ask community partners what they would like help with, and work hard to earn their trust.
2. Lesson: our campus already has many outstanding outreach programs. Recommendation: establish genuinely reciprocal partnerships with existing campus outreach groups and learn from them.
3. Lesson: undergraduates have abundant creativity, energy, generosity, and leadership potential. Recommendation: allow undergraduate volunteers to decide what their outreach efforts will be, empower them to lead their peers, and provide them with a balance of autonomy and support.
4. Lesson: it's easy to be inundated with community requests for help. Recommendation: establish goals at the beginning of each school year, review these goals regularly, and learn how to efficiently and fairly manage community requests in order to protect students' time and energy.
5. Lesson: you can do a lot with relatively few resources, and undergraduates are thrilled to get a free meal! Recommendation: find and model inquiry activities that use cheap, safe, household supplies whenever possible. Ask K-12 schools/PTO organizations to provide a free meal to student volunteers who visit their school.
6. Lesson: funding can come from unexpected sources. Recommendation: look for institutional and private grants that support student community service, and encourage K-12 community members to consider donating funds to ensure future outreach.
7. Lesson: challenges with students/volunteers may arise simply due to inexperience of undergraduates. Recommendation: establish an open, responsive environment to actively discuss problems and create plans to address any issues that arise.
8. Lesson: in the end, it's all about the students. Recommendation: savor the moments when undergraduates and K-12 students connect via their mutual love for science.

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partner, the Wisconsin-Heights School District, for their generous donation of classroom space for our Summer Science Camp, After School Science Club, and NGSS course for K-12 teachers.

About the Authors

Faculty Associate Michelle Harris has been an instructor in the University of Wisconsin-Madison Biocore Program since 1999, where she teaches cell biology and physiology lab courses using a process of science approach. Sara Grange graduated from the UW-Madison in 2017 with a Bachelor's of Science in genetics with Honor in Research, along with a minor in environmental studies and currently works at the USGS National Wildlife Health Center. Austin Feeney is a UW-Madison 4th year undergraduate student majoring in Biomedical Engineering with a focus in Biomaterials and a certificate in Biology in Engineering. Scott Odorico graduated from the UW-Madison in 2017 with a Bachelor of Science in Biology with Honors Distinction, and a minor in Business/Finance.

Table 1. Outreach responsibilities, time commitment, challenges, and rewards for BOA undergraduate volunteers, undergraduate co-chairs, and the instructor/advisor.

	BOA Student Members	BOA Student Leaders	BOA Advisor
Responsibilities	<ul style="list-style-type: none"> Teach science underlying simple experiments Use a step-wise inquiry-based approach to help kids understand concepts Execute goals outlined by the BOA leadership team Represent the UW-Madison to the public 	<ul style="list-style-type: none"> Organize outreach activities with collaborators and local schools Ensure the quality of information communicated to and between BOA members Connect UW-Madison science outreachers and local schools through the Wisconsin Idea Meet weekly with BOA advisor to plan & coordinate activities 	<ul style="list-style-type: none"> Meet weekly with BOA co-chairs Initiate and maintain contact with community partners Organize & lead the Summer Science Camp Assist with grant writing Attend Science Nights twice per semester Serve as a “quality control” check, ensuring that ambassadors appropriately and proudly represent our Biocore Program and the UW-Madison Wisconsin Idea.
Time Commitment	~10 hours/ semester	~40 hours/ semester	~5% of all duties
Challenges	<ul style="list-style-type: none"> Maintaining the focus of young kids Leading kids to the make their own reasonable conclusions Asking questions that help kids reason their way to answers Balancing outreach with academic & extracurricular commitments 	<ul style="list-style-type: none"> Identifying potential outreach partners Training BOA members Obtaining grants to fund outreach projects Balancing outreach with academic & extracurricular commitments Maintaining communication between all BOA volunteers and collaborators 	<ul style="list-style-type: none"> Quality control: ensuring that BOA volunteers are effectively interacting with children & teachers as they model process of science Finding new funding sources Balancing outreach with other duties Maintaining contact with K-12 partners How do we measure outreach impacts on undergraduates, K-12 students, and teachers?
Rewards	<ul style="list-style-type: none"> Understanding concepts through teaching Making a positive impact on budding scientists and serving as university-associated role models Appreciate the teaching profession and gain insight into their own university instruction Promotes reflection on knowledge of concepts Smaller, supportive peer community within a large university 	<p>In addition to all rewards experienced by BOA members (listed at left), BOA leaders:</p> <ul style="list-style-type: none"> Develop professional interaction & communication skills with the public & other campus outreach programs Develop peer leadership & mentorship skills Gain experience organizing large events 	<p>Witnessing:</p> <ul style="list-style-type: none"> undergraduates’ growth as scientists & professionals as they interact with the public K-12 teachers transform their teaching approach after BOA interactions undergraduate students develop an appreciation for K-12 teaching how undergraduates’ learning is enlightened and/or reinforced through their outreach efforts joyful interactions between undergraduates and K-12 students

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