Instituting a Community Based STEM Program at Drexel University's College of Engineering: Understanding Factors That Determine the Success of University-Community Partnerships

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Introduction

The Community Based STEM Program is an engineering focused service-learning program housed in the College of Engineering at Drexel University. Through this program, faculty led student-groups work together to solve real world challenges presented by local community partners. In the College of Engineering, this is one way to provide students with professional skills and volunteer opportunities, provide faculty with an bridge to link their academic expertise with civic engagement, promote improved perception of the University as part of the community, and equip community partners with support on STEM initiatives. In a broader sense, the program aims to develop students as leaders who can engage in critical thinking skills to address community needs and solve those needs through an integration of service learning and design. The future of engineering requires individuals to be strong communicators and engage in teamwork and problem solving.

The Community Based STEM Program is an engineering service learning program designed for engineering students to help them build professional and leadership skills. This is an engineering projects in community service program (EPICS). The EPICS program and model was started at Purdue University. It is proven to be effective at retaining minority and female students, building leadership skills, and supports faculty development. It is considered a well-respected model for service learning in engineering and promotes interest and practice in the STEM fields. The basic idea for the Community Based STEM Program is for students to design, build, and employ real systems to solve engineering-based problems for local community service and education organizations. The program's design was very simple and required three elements - each program would have a faculty mentor, students, and a community partner who expresses a need for a solution to an engineering design challenge.

In 2013, under the guidance of a new Dean, the Community Based STEM Program was introduced to the College of Engineering through various informational sessions and direct communication to faculty who were already involved in community service work. The program was chosen because it is deemed a successful model for service learning for engineering students and was well known by some faculty. The program gained some traction with the introduction of a new STEM Coordinator who provided much needed administrative support. Additionally the Community Based STEM Program supported the mission and vision of a new College-wide strategic plan that set as one of its goals "to create a boundaryless learning environment and empowering student experience."

In its implementation, the program coordinators encountered many challenges that included little, if any existing network to build on for community programs, constraints in curriculum, overcommitted faculty and lack of administrative support; however, after two years the program saw some success. It saw improved relations with community partners that led collaboration agreements and support for each other's research and grant proposals, 17 distinctive projects with these community partners, and four spinoff research projects.

Background

21st century jobs require a new set of skills, many of which are connected to the science, technology, engineering, and mathematics (STEM) fields.[1] Colleges and universities seek to promote academic excellence but are also responsible for developing students as active citizens. To meet future needs and to grow knowledge capital, there must be investment in technology and support for programs that promote innovation and spur leadership. Colleges and universities are well poised to support this development through targeted programs that are hands on, promote skill development, solidify career interests, and enhance social skills for young people. Additionally, university-community partnerships in service learning can support civic engagement goals and help solve social problems.[2] The Community Based STEM Program is one example of a program that builds on students' academic foundation and relies heavily on technical skills to promote students as involved leaders who engage with their community to enact change.

The freshman and sophomore curriculum in the College of Engineering, like at many other schools, focuses on chemistry, calculus, physics, engineering design and English. It leaves little room for elective classes and lacks civic engagement opportunities with the community in a structured environment. In recent years, students at the College of Engineering were required to complete 5 hours of volunteer work in their first year. Students were able to choose from a variety of options on a database or find their own activity. Activities included volunteering at a charity walk, tutoring youth, and being a computer instructor. However, with many of these activities, students simply visited a community partner once or twice and did not have any long-term relationship with the community partner. The Community Based STEM Program aimed to increase opportunities for students to pursue civic engagement in a more structured way and one that is more aligned with the engineering curriculum and is imbedded in their existing classes.

Process

Each project in the Community Based STEM Program involves three participant groups: 1) community organizations, 2) faculty/team mentors and 3) students. The first step in implementation was to identify organizations/partners for collaboration. The next step involved identifying projects and matching those engineering challenges with an interested faculty member, and lastly it was to pitch the idea to the students. The process was time consuming and required multiple conversations and coordination with faculty members to ensure the project ideas were challenging enough to meet department specific course requirements and only where there was an interest by the faculty member were we able to follow through with the organization. It was discovered that a 6-12 month lead-time was needed to launch match all of the participants groups.

Once the community partner and faculty were matched, the programs were then offered to the students typically as either a senior design or freshman design project. Student groups that chose these projects over others were eager to apply their engineering skills to help a community partner. In AY 13-14, faculty members recruited students for all of the projects. In AY 14-15 faculty members continued to recruit students but potential projects without faculty support were posted online and students identified interest first and then contacted faculty for support. It became the students' responsibility to then find a faculty mentor to lead their group.

Factors for Implementation and Challenges

Service learning is a mechanism for both teaching and learning.[3] Factors that determine the success of university-community partnerships can include geographic proximity, institutional leadership, community based research, funding, and curriculum flexibility.[3] While each of these factors is present, it is important to note that some aided in its success and others presented as a barrier to its implementation (See Table 1). For example, the community surrounding the University is urban, underserved and culturally diverse. Community partners within a short distance of the University include community-based organizations (CBOs) working to serve the immediate community as well as well-established informal learning institutions that serve the city and region. This factor had a significant impact on the type and scope of projects offered and aided in its success. Additionally, it presents a terrific opportunity to link community-based operations research (CBOR) that focuses on community problems.[4] In understanding the challenges of a community, it is necessary to understand the needs of the population and place an emphasis on the needs of those living in well-defined neighborhoods. The local nature of the problems exerts a strong influence and helps to shape the outcome. Exposing engineering students to the community around them and then requiring them to incorporate the needs of the community, allowed the students to think more broadly about the application and design of their projects.

Factor	Description	Accelerator/Barrier
Geographic proximity	Urban, underserved, diverse Home to various informal learning institutions	Accelerator, positive supportive factor
Institutional leadership	Deans/College Support Government relations Community center	Positive support factor, unable to fully leverage University resources
Community based research	Office of Research Support Active research faculty seeking living laboratory opportunities	Positive support factor, promoted faculty involvement
Funding	Deans funding for projects (up to $1000.00 per project) Additional support for training and meeting with community partners	Positive support factor, promoted faculty involvement
Curriculum flexibility	Rigid - limited and lacked flexibility for add-on programs Co-op program created time constraints	Barrier, unable to offer interdisciplinary programs, limited student participation to Freshman and Seniors

Table 1: Factors for University-Community Partnerships

Project type was largely dependent on the organization type (i.e. neighborhood CBO or informal learning center). For CBOs serving the immediate community, projects were clearly defined and targeted a specific population, for example, the design of a handicapped ramp to provide disabled veterans with access to a community center. Others were more opaque and required students to develop STEM learning displays that demonstrate engineering principles to audiences of all ages. To our benefit, the community on a whole had a positive association with our College, making it easier to discuss the program and ask for assistance. Some project leads also came to us from community organization looking to partner with the College.

Even though there was staff support and financial resources for projects, there were still significant challenges to implementing the program into the College. The undergraduate engineering curriculum in the College of Engineering is very limited and lacked flexibility for add-on programs. In the student's first and second year undergraduates must stick to a well-defined curriculum. Drexel University is a cooperative education institution therefore during the sophomore and junior years students have class for 6 months (2 quarters) and coop for 6 months (2 quarters) adding a time and commitment challenge for our students; therefore, when deciding on implementation options and entry points for the Community Based STEM Program there were little options to offer projects for credit outside of design courses. One solution was to find a way to institutionalize the program by offering it as a credit bearing course students could take as a non-technological elective in their program; this would also allow students from outside of engineering to register and participate in the project. To do so, the course would be offered as general engineering elective. Both engineering students and non- engineering students could then register for these courses for credit. When presented, at first the idea was received positively but in the implementation phase it did not receive wide support from senior administrators, and stalled. Discussions are ongoing and focus on offering the program as a service-learning course with interdisciplinary organizations/departments on campus. In the meantime, the program is imbedded into select freshman and senior design classes where a project topic fits with the professor's interest.

Additional challenges included those related to scheduling and timing. It was important to start the discussion early enough to offer the program according to the senior or freshman design schedule - and also required time to match faculty to projects based on discipline, interest and teaching responsibility.

Outcomes

By embedding this program in already established student programs (senior and freshman design) instead of offering it as a separate elective class, we were able to offer this project option to students in all engineering disciplines. In our pilot year (AY 13-14), 38 students (20 male, 18 female) in groups of 4 to 5 participated in nine projects. Sample projects included: a design for a handicapped ramp for a community center, water powered exhibit add-on for a children's museum, portable lightweight and waterproof lawn chair design for a historical garden center, and low cost robots to be used as educational exhibits at a maritime museum. In the second year (AY 14-15), the project number has remained constant, but there was a shift away from previously established programs to working with organizations vetted by the Community Based STEM Program coordinators. Projects in AY 14-15 included: a solar canopy for a local schoolyard, composting facility redesign in the neighborhood adjacent to the College, and interactive lessons and demonstrations about energy for a prominent children's museum (see Table 2).

Type	Community Partner	Year	Type of Community Partner	Initiator	Project Description
Senior Design	Thai Harvest	13-14	International development	Faculty	Redesign and testing of mechanical seeder for Thai community
Senior Design	Thai Harvest	13-14	International development	Faculty	Bio-sand water filtration for community in Thailand
Honors program	Bartram's Garden	13-14	Local/Informal learning	Program Coordinators	Design & manufacture of portable lawn chair
Freshman Design	Please Touch Museum	13-14	Local/Informal learning	Program Coordinators	Add-on exhibit display, water light up wheel
Freshman Design	Cobbs Creek Community Center	13-14	Local/Community	Program Coordinators	Handicap ramp design for steep incline
Senior Design	Climate Central	13-14	Research Facility	Faculty	App for climate data
Senior Design	Drexel Medicine	13-14	University	Faculty	Communication device for ALS patients
Senior Design	Independence Seaport Museum	13-14	Informal learning	Faculty	Underwater robotics education display
Senior Design	Mantua Peace Garden	13-14	Local/Community	Faculty	Bench for garden
Senior Design	Bartram's Garden	14-15	Informal learning	Program Coordinators	Container redesign/solar lighting project
Senior Design	Bartram's Garden	14-15	Informal learning	Program Coordinators	Riverside kayak storage container redesign
Senior Design	Drexel Medicine	14-15	University	Faculty	Communication device for ALS patients
Senior Design	Dirt Factory	14-15	Community org	Program Coordinators	Composter redesign for community scale
Freshman Design	Please Touch Museum	14-15	Informal learning	Students	Human assist device
Senior Design	Please Touch Museum	14-15	Informal learning	Program Coordinators	Interactive game - Electrical Engineering concept
Senior Design	McMichael School	14-15	Community/Formal learning	Faculty	Solar energy/garden project

Table 2: List of Community Based STEM Projects

With larger informal learning institutions there was the identification of research projects, living lab opportunities, and a desire to collaborate on displays demonstrating engineering and STEM concepts. Successful partnerships provided a great opportunity to improve the College's reputation in the community and provide spin-off research projects for faculty. With the larger informal learning institutions, the process involved more administrative processes and took longer to identify project ideas for the students. Smaller CBOs had a clear need for technical help with an engineering challenge making it easier to start the project once a team was identified.

For civic-minded faculty, there was appreciation of the prescreening work in identifying organizations, projects, and resources to help them engage in projects of interest. Faculty interested in community-based research were more successful at working with partners and identifying appropriate student projects than those focused on laboratory research. Spin-off research projects are ongoing with community partners regardless of if they became participants in the Community Based STEM project or if they just engaged in preliminary discussions. Additional efforts to engage faculty included inviting community organization representatives to campus to host open discussions to generate interest with faculty. This helped to engage faculty that would otherwise not participate or engage with an organization on their own. This effort was successful and drew faculty that were uncertain of how to engage or get a project off the ground. Overall those who did participate were very engaged, communicative, and appeared to be excited about their students' projects. Faculty that participated in year one also participated in the second year.

Despite the challenges, we were successful in implementing the program in the College in AY 13-14 and AY 14-15. The implementation of this model and its adaptation locally has shown that the impact can be greater when community assets are linked and leveraged to work together. We were the most successful in matching teams with community organizations within 3 miles of the University. They included small CBOs and well established informal learning institutions (i.e. museums, zoos, environmental centers) all of which recently expanded their strategic plan to include STEM initiatives and better integration with the local community. We had additional success with organizations that reached out to the College of Engineering for help with a particular design challenge.

Assessment

A survey was developed for students which included open ended questions such as: what did you learn that relates to your discipline, what did you learn about service learning, what are the broader impacts of the project, and how can you or others affect change at the global or local level. There were also questions, measured on a likert scale (strongly disagree to strongly agree), about how the project may have aided in the student's ability to function on a team, understand project design, gain new knowledge, and become aware of community needs. The survey was distributed to all supervising faculty to pass onto students and was also later sent to many of the students directly. The survey also provided an opportunity to collect demographic data on participants. Initial survey response rates were low and for AY 14-15 alternative methods are being discussed.

Lastly, more assessment needs to be done on the impact the program may have had on supervising faculty, community partners, and spin off research projects. Most of the faculty who volunteered to lead these projects had a history of participating in service learning and other community or volunteer programs while employed by the College prior to the start of the Community Based STEM Program. Financial awards ($1000 per project) were limited but still appeared to serve as an incentive for faculty because project materials were easier to obtain with available funding.

Conclusion

Even if met with challenges, the implementation of this innovative program was successful in its first and second year at the College of Engineering in large part due to the positive supportive factors: geographic proximity to many community based organizations, institutional leadership and support, community based research and interest by faculty in the projects. The factor that presented itself as a barrier was the rigid curriculum that lacked flexibility. And while this limited the roll out of the program it also provided an opportunity to embed the program in freshman and senior design. Some intended outcomes were realized such as student participation and having multiple groups involved with various community partners. Other unintended outcomes also occurred; these include improved understanding of engineering and the College, feeling of goodwill and partnership in the community, and building a culture of community service within the college. Funding will continue and can be viewed as an incentive even if it was not the main motivator for most faculty or student groups. There is also a plan to reach out and present opportunities directly to the students to initiate projects.

Overall, this is a program that supports the University's strategic plan to improve the student experience, and the College of Engineering's Strategic Plan to involve the community and build the STEM pipeline. This project is just one STEM framework that can enhance university-community partnerships. Identifying factors needed to determine the success of this type of program helped to frame the rollout efforts and identify strengths and weaknesses within the college structure.

References

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