Engagement in Practice: Scaling Community-based Design Experiences

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Abstract

For engineering community-engagement to realize its potential, a diverse set of models that can be scaled need to be developed and disseminated. The EPICS Program, founded at Purdue University, is a curricular approach that has proven to be scalable. EPICS involves undergraduates in the development, design, delivery and support of technology-based solutions to meet needs in the local and global communities. It co-develops and implements solutions with community partners using a human-centered design approach, actively engaging stakeholders in every stage. Since the creation of the program in 1995, over 400 projects have been delivered to a wide range of local and global community partners. This paper highlights strategies that have allowed EPICS to grow to over 1100 students from an average of 45 majors per year.

Introduction

Community-engaged learning came to engineering slower than many other disciplines [1] but has seen increasing examples and scholarship in engagement [2, 3]. Evidence of the increasing acceptance includes the creation of the ASEE Community Engagement Division. While there are many examples of success, most are driven by individual faculty or small groups and there are few examples of large scale implementation of engagement. For community engagement to achieve its potential, models that can be replicated or adapted and integrated into the fabric of the institutions must be developed. There is still skepticism about service-learning as noted in the 2014 ASEE report [4]. It showed that service-learning was not widely implemented nor was it considered important as seen in Figure 1. Nearly two thirds of the administrators believed it was not practiced at their own institution and did not deem it important to change.

Successful models that have scaled include the ambitious Service-Learning Integrated throughout a College of Engineering (SLICE) program at UMass Lowell. Their approach integrated engagement into multiple engineering courses as projects and assignments that complimented the existing course across all of the engineering disciplines [5]. Another approach is a series of dedicated design courses that use the service-learning pedagogy. The EPICS (Engineering Projects in Community Service) Program, at Purdue University, is such a model. EPICS has been well-documented in its curricular approach to engagement involving undergraduates in the development, design, delivery and support of technology-based solutions to meet needs in the local and global communities. [6-9] EPICS co-develops and implements solutions with community partners using a human-centered design approach, actively engaging stakeholders in every stage. The curricular structure supports projects that span multiple semesters and even years. Since the creation of the program in 1995, over 400 projects have

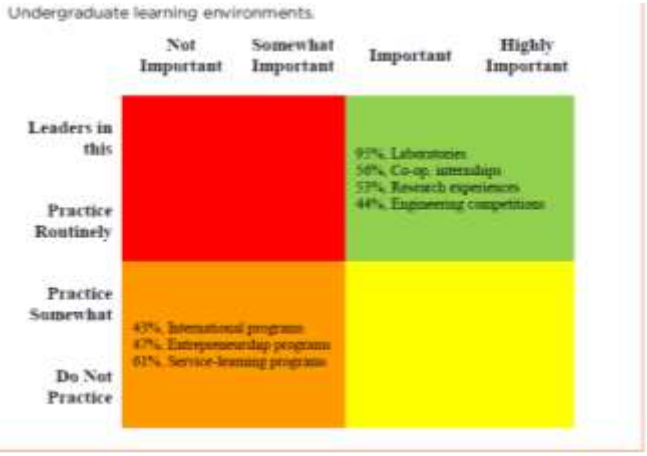

Figure 1 Reaction to Undergraduate Learning Experiences [4]

been delivered, ranging from software to allow agencies to coordinate services and protect privacy, to a constructed wetland to purify agricultural runoff, to a communication iPad app for children with autism, and an accessible camp for children with disabilities [8]. Examples of projects are listed in Table 1 along with their respective community partners.

TABLE 1. SAMPLE ACTIVE AND PAST PROJECTS AND THEIR DESCRIPTIONS [7]

Team Name	Description	Partners
Camp Riley	Make Bradford Woods, which host camps for kids with disabilities more accessible. Active projects include an augmented reality sandbox, electronic sensory games, and an accessible sailboat.	Camp Riley, Bradford Woods, CHAMP Camp
Cellular Engineering Demonstrations	Design and create interactive models to engage young children. The goal is to teach individuals ages 10 and up about science, with active projects of a bioreactor, earthquake simulation, and hydrology.	Indianapolis Children's Museum.
Columbian Park Zoo	Design infrastructure and educational materials. Current projects include an interactive donation box for the butterfly exhibit and an electronic birdcall-matching game for the birds of prey exhibit.	Columbian Park Zoo
Database and Innovative Software for the Community	Create scalable data-centric applications meant to track and organize project partners' information. Current projects include a simulation of a speech and hearing assessment, a database system for a local retirement community, & a lactation-consultant communication app.	Purdue Speech, Language, and Audiology Clinic and School of Nursing,, Westminister Villagee
Environmental Improvement Initiative	Develop sustainable projects within the community and the University. Current projects include an energy audit and design of a reflection pool and the design of an outdoor recreation facility.	Indiana Veterans' Home, Northview Church
Global Alternative Power Solutions	Developing alternative energy solutions to provide power to remote rural villages and underserved urban communities in Colombia through collaborations with universities and communities.	University of Antioquia, Medellin, Colombia
Greater Lafayette Area Special Services	Develop technological solutions which enable students with disabilities aged 3-21 to function more independently and enjoy a better quality of life.	Greater Lafayette Area Special Services (GLASS)

In recent years Purdue University's EPICS Program has grown significantly to enroll over 1100 students per year working on 147 projects are impacting 83,111 people directly. EPICS is fully institutionalized and sustained with recurring funds, faculty teaching credit and corporate support. EPICS courses count for credit within every college in the university and are part of the university's core curriculum (fulfilling the Science, Technology and Society requirement), as an option for the Entrepreneurship Certificate and elective in the Leadership minors. The growth in recent years has stretched the EPICS model, forcing new approaches. This paper shares the process used and lessons learned in scaling the successful community-engaged learning program.

Scaling EPICS

Enrollment in the EPICS courses at Purdue University grew from approximately from 40 in the initial year, to 300 students per semester in 2007 and to nearly 600 students per semester in 2017 (**Error! Reference source not found.**2). This growth stepped up significantly from the fall of 2015 to the fall of 2016, and has strained many of the traditional methods for administering the course. The basic structure and function of the EPICS courses have been previously described [6-9]. Several changes have been made to systems to facilitate the growth in enrollment.

Figure 2 also shows the number of students who have returned for more than one semester starting at 2007. We have relied on students to be part of the continuity between semesters. Returning students lead the classes and the transition between semesters. This eliminates faculty having to reinvent or restart the projects each semester. The lab sections average 16 students and usually there are students returning for the next semester. The program has instituted training and networking sessions for the project managers, who are the students leading the sections to learn new skills and to share best practices.

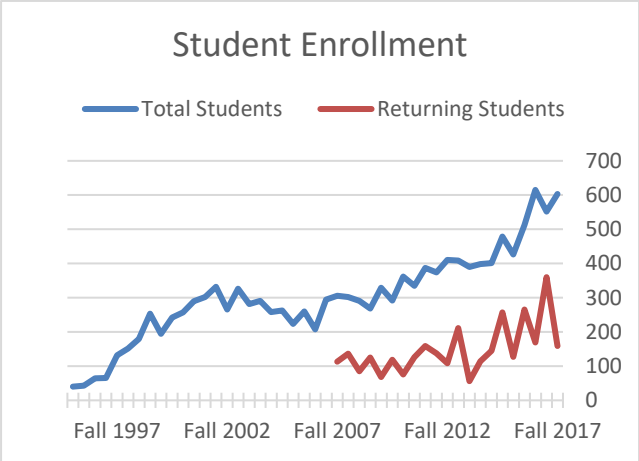

Figure 2 Student Enrollment

A hallmark of the EPICS program has been the development of long-term community partnerships and this has also facilitated the growth. The unit of engagement is at the partnership level rather than the project-level. Community partners sign MOU's with EPICS that are for five years. The intent it to work together identifying needs that can be addressed by multi-disciplinary teams of undergraduates. As projects are completed, new needs are identified and new projects begun. Fielded projects are supported by subsequent teams working for that same partner. This adds to our ability to grow as we do not have to find new partners or projects each year and it adds significant value to the community partners as they know we will work with them until a project is delivered and then support that project in use. In the 2017-18 academic year, EPICS recognized four partners for their work and three of them started with the program in the 1990's showing the longevity of the partnership model.

Support Structure

Dedicated staff support has been put in place to assist the faculty involved and allow the program to engage more students and community partners. The program is designed to make it easier for faculty to be engaged. Engagement courses typically require significantly more time than traditional courses with the model that the faculty manage all aspects of the course and partnerships. This becomes a significant barrier to faculty participation, especially at research institutions. EPICS has sought to provide scaffolding around the faculty to allow them to focus on the students, their learning and managing the progress of the projects themselves. The program provides the overall curricular and assessment structures as well as the model for partnerships and the actual community partners. This model reduces the time investment of the faculty to closer to a traditional course. It also provides measures of consistency across the 40 sections of the course. The faculty load has been measured based on student credit hours and associated workload and the EPICS course typically counts as a half of a course for faculty release time. When faculty are assigned to the courses, they make a year-long (two semester) commitment which provides instructor continuity.

EPICS refers to the instructors as advisors to reflect the student-driven experiential learning environment. Advisors coach the students but do not direct and lead. In the spring of 2018, there

were 53 advisors, with some sections being team taught. Recruiting advisors has been a continual challenge. The program over the years developed agreements with departments to assign faculty, however, when budgets get tight, these are one of the first items cut as EPICS as a multidisciplinary program is not directly connected to any one engineering department. We continually recruit faculty, with some receiving teaching credit and others participating as an overload. Several have written EPICS into their grants as their education and outreach activity and teach a section to fulfill that commitment. Other faculty connect to their research. Still others find it rewarding and volunteer.

Table 2 Key Support Staff

Key Staff Positions	Responsibilities
Program Coordinator	• Identify, Develop and Nurture Community Partnerships • Manage student enrollment and interface with academic advisors • Manage purchasing of materials for projects
Academic Administrator	• Manage and train teaching assistants • Onboard new faculty advisors (instructors) • Manage assessment and curriculum for the program
Lab Manager	• Manage the physical lab spaces • Set and manage protocols for equipment and materials
Secretary	• Interface with students and visitors • Distribute purchased materials to students • Manage the invitation process for design review visitors

Team advisors come from various sources in addition to faculty. University staff who want to work with students gain permission from their management who see it as a way to contribute to the engagement and teaching missions of the university. Another source of advisors has been local professionals from industry. These volunteers are given a title of visiting scholar, which has no pay but allows them to get a university ID which allows access to the libraries and other resources. A best practice has been to make an agreement with their management to help find a replacement if the volunteer moves, is promoted or cannot complete a semester.

As part of the recent growth, the program added two dedicated continuing lecturers who can teach multiple divisions of the course. These have helped significantly and we believe that we would add more if we continue to grow. They can teach 12-14 of the 40 current sections that allows us to move them around as needed. Most of the EPICS staff also teach or co-teach sections, 23 of the sections are advised between the Director and staff, allowing them to overlap with and mentor new instructors. In total, 40 sections have a member of the EPICS leadership team involved. When new advisors, faculty, staff or industry, are brought into the program, an experienced advisor, usually one of the EPICS staff, mentors that person for at least a semester.

Lecture to Professional Development Hours (PDH's)

The core of the EPICS courses is the project work but students are also required to participate in a number of learning activities to equip them to do the design work and engage with their community partner. In the early years of the program, the methods for the instruction included lectures and interactive skill sessions, which are typically one-hour introductions to various technical and professional skills. The lectures consisted of two five-part series – one for new students and one for returning students. Students new to EPICS need an introduction to the

design process and methods to engage with the community. Returning students who have been in EPICS can benefit from further insights or additional tools to advance their work and learning.

To keep providing the information needed by the students at scale, all of the "lectures" were moved to interactive on-line modules. When this was done, the terminology was also changed from the lecture requirement to a Professional Development Hour (PDH) requirement. EPICS seeks to model professional practices and modelling PDH's after the PDH requirement for Professional Engineering licensure was another step in that direction. There are five PDHs mandated for each student taking EPICS for the first time (Table 3). Students can and most do take EPICS for multiple semesters, and the PDH's may be chosen by the student with input from their advisor and team members. Dozens of PDH sessions are held each semester, including skill sessions conducted by teaching assistants and staff, guest lectures from faculty across campus, and leadership seminars from invited guests. In addition, students can utilize on-demand, individually paced learning through a library of YouTube modules and recorded lectures and presentations. By offering a variety of learning activities that align with course goals, students are able to select content that is relevant to their specific project and appropriate to their current phase of the design process and personal development.

Table 3 Required Professional Development Activities for First-Time EPICS Students

First-Semester Student	**Required Professional Development Hours**
Introduction to EPICS	5 part YouTube series includes overview, course structure, grading, resources, and safety/emergency procedures.
Wallet Project	TA-led small group activity gives hands-on experience through a complete design cycle.
Design Process Module	3 part YouTube series includes design process overview, phases and tools, and best practices.
Design Process Self-Study	Assigned reading of human-centered design process along with completing quiz.
Ethics	4 part YouTube series includes common design ethics scenarios, moral, professional, and ethical codes, and ethical frameworks.

Design Reviewer Recruitment

Consistency is a challenge among 40 sections and conducting design reviews twice per semester, once at the midterm and once in the final weeks of the semester, are a mechanism to increase consistency that involves external reviewers. The design reviews also provide needed technical recommendations for the projects, as well as giving the student teams an opportunity to practice professional skills. Design reviewers include faculty from across campus and corporate and alumni partners. Reviewers from local industry have long formed the backbone of the pool of individuals that review the teams; however, as the number of teams increased it became a challenge to recruit sufficient reviewers. In order to meet the demand for reviewers, recruitment efforts were ramped up to non-traditional sources as well as to an expanded geographic area. Two relatively untapped sources of reviewers were pursued: alumni of the program and local retirees. To recruit alumni, a call for reviewers was sent through alumni email lists and social media channels. Recognizing that travelling to campus was one of the barriers, each of the classrooms was equipped with web-based communications systems that allow alumni or corporate partners to participate remotely.

The participation of retirees increased significantly when we asked one of the most loyal participants, a retiree himself, to be the lead recruiter. He used personal invitations to add many quality reviewers. The increase in design reviewers through these recruiting efforts again strained the administrative systems for identifying and placing the reviewers on teams. An email driven system with manual tracking was replaced with a Qualtrics survey, which reduced risks of miscommunication and streamlined information collection including nondisclosure documents, which allow students to protect potential IP.

MyEPICS software as an Administrative Platform

MyEPICS is a website and database that were originally created by a student team and moved to a local software company for development and support as the complexity of the software increased. Administrators can schedule learning activities, define team members and leadership roles, administer and review peer evaluations, track projects and partners, and manage safety and other administrative forms. As the EPICS program has scaled, MyEPICS has facilitated growth without overburdening the course administration. In particular, MyEPICS has provided a platform for students to peruse a menu of PDH options, register to attend live sessions, complete attendance quizzes for online sessions, and track completion toward their PDH requirements. This has allowed large number of students to self-manage a complex offering of PDHs while providing their instructors with easy access to their attendance records. MyEPICS provides a robust set of fields for course administration to customize PDH offerings. In addition to specifying the logistics of each session, links to lecture slides, YouTube videos, or other supplementary materials may be supplied directly to the students. The inclusion of the Specific Question field allows quiz questions to be created to verify completion or to add guided reflections to each activity.

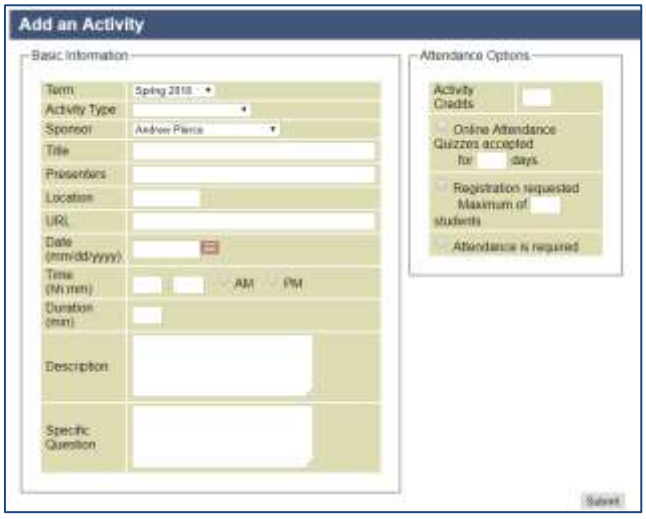

Figure 3 MyEPICS Menu

Summary

EPICS has significantly increased the number of students and partners engaged with the program. Data shows that student evaluations have held nearly constant as the program has expanded [7]. Community partnerships continue to grow with a waiting list of partners and a high rate of partner retention that point to success of the program. A study of alumni showed that participation in the program benefited graduates in their careers in industry [11]. The number of people who have been impacted in the 22 years of the programs exceeds 3 million people. The university consortium continues to increase nearly doubling over the last four years to 46. The K12 adaptation of the EPICS has grown to schools in 17 U.S. states. Challenges remain and are a challenge every year with the program. However the successes and value-added to the university has the administration planning for further expansion.

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