Engaging First Year Students through Service Learning Projects: Designing for Community Gardens

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Abstract
At Gannon University, the First-Year Seminar in Engineering has nine course outcomes: five common to all First-Year Seminars in the university and four specific to engineering majors. Two of those outcomes are (1) become familiar with the engineering design process, and (2) demonstrate the ability to analyze what has been learned from their engineering service learning experience. A semester long, community-based project is employed to meet these two outcomes. This service learning project is the pivotal experience connecting and building not only engineering competency but also personal confidence. Emphasizing the service-learning aspect, the learning becomes relevant and the first-year students excel as they share the intellectual, problem-solving aspects of design.

The university's community garden has provided projects for this service learning, hands-on experience for the last two years. The projects selected have been a rainwater collection system for a flat roof and vertical planters to increase production. The guidelines from the EPICS program at Purdue University have been modified to guide the freshmen through the design process.

This paper presents an overview of the seminar, and the content connected to the community-based engineering project. The projects designed and implemented are described as well as their adaptability to any community garden. The methods used to evaluate the students' performance are presented outlining their connection to the community-based engineering project. Keys to successful implementation of service learning projects are discussed in the lessons learned. The impact of the service learning, community-based project is supported by the students' self-reported increased appreciation for the aspects of engineering design and understanding of engineering solutions in a societal context.

Introduction and Motivation

Service-learning challenges students to translate class topics into "real world" applications while providing a tangible benefit to the community. Interdisciplinary hands-on projects requiring interaction in small groups with high faculty collaboration are valued as a factor for improving retention[1]. The projects do not need to be within the student's primary discipline;

communication and dialogue, sharing of ideas and approaches are more important. Adding a service-learning component to a project can enhance learning, especially in the areas of social and moral development[2-4]. The First-Year Seminar in Engineering, a required Liberal Core 2-credit course, was restructured to incorporate a community-based engineering project.

The role and functions of community gardens are under increasing attention as society struggles with issues of food security, increasing food prices, usage of chemicals in agriculture and the environmental cost of growing and distributing food. Community gardens are a venue for activities that support local sustainability, health promotion and community development[5-7]. Food-producing community gardens can be a limitless source of engineering projects for first-year seminars. Presenting the students with data that clearly identifies a specific, compelling need to be addressed during the project definition stage is imperative. Figure 1 presents a template that can be adapted to any city to present the data needed for this argument. Note that a specific area within the city should be selected. Figure 2 shows a visual representation of the selected area for the project indicating poverty rates and locating community gardens, food pantries and Kid's Café.

Food Security: Erie vs. US stats

City of Erie

- 2010 poverty rate = 30.2 %
- approx. 75% of children qualify for National School Lunch program = 100% coverage
- 4 Kids' Café programs in Erie (funded by 2nd Harvest FoodBank)
- 3 largest food pantries in Erie are located in the Erie-GAINS neighborhood at: Emmaus Soup Kitchen, Erie City Mission, St. Patrick Parish
- estimated 13 Erie comm. gardens

National Comparisons

- 2010 national poverty rate = 16.1
- districts w/ 40%+ of students at 130% of the poverty level qualify for "community eligibility" or 100% student coverage for National School Lunch program
- 17,000 Kids' Cafés nationally
- 1 in 6 Americans faces hunger
- estimated 18,000 community gardens across the US

Figure 1: Data on Food Security for needs assessment and social context

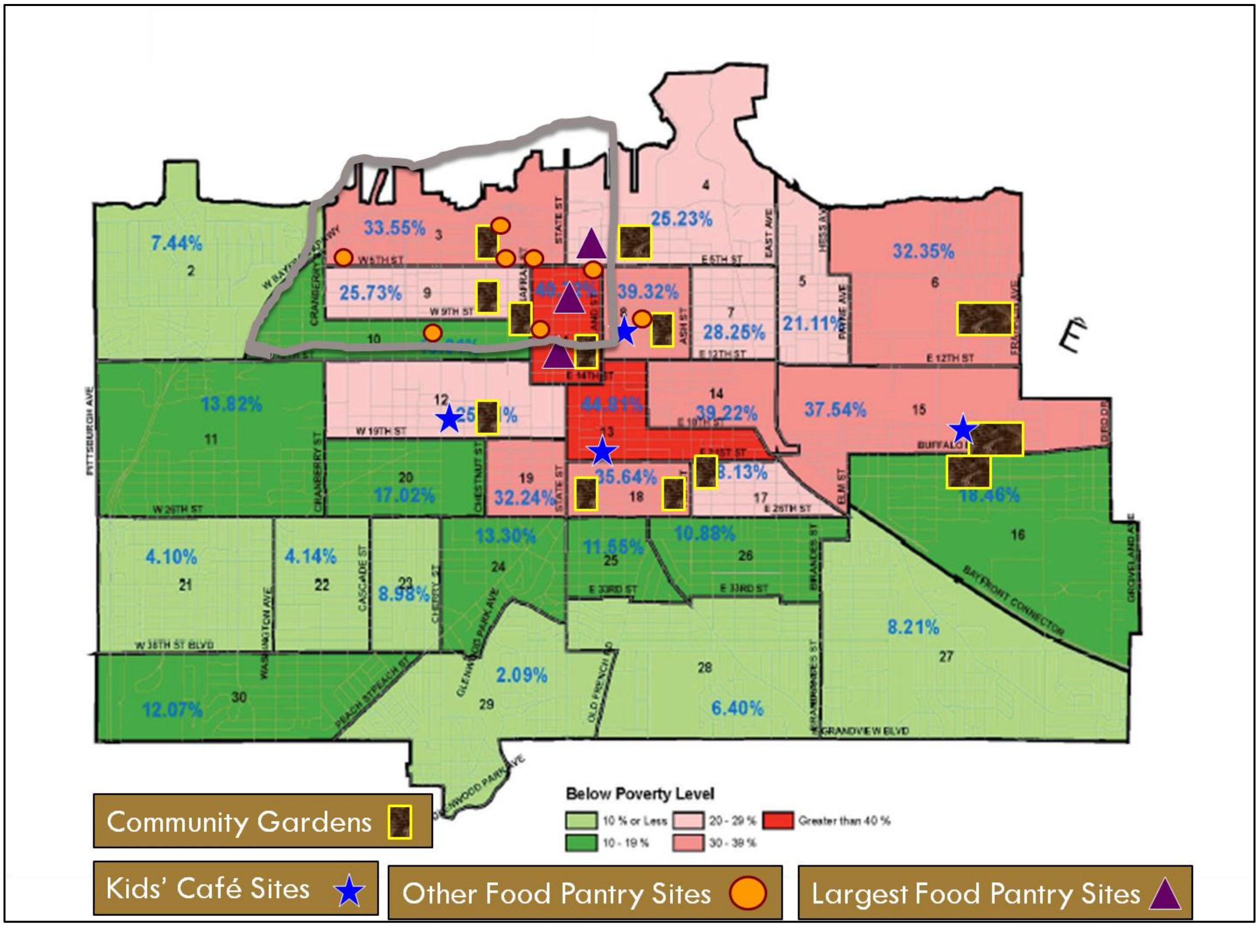

Figure 2: Census map indicating poverty rates, community gardens, food pantries and Kid's Cafe sites

Engineering Projects for Community Gardens

A large array of engineering projects can be identified in a community garden. Projects can range from research initiatives to short-term, semester long activities. Table 1 presents a list of projects that have been identified and performed in freshman level courses in the School of Engineering during the last two years. The goal is to provide the freshmen students an engaging experience where the design process is applied and a tangible product is obtained at the end of the semester. Amongst all the projects listed in Table 1, the vertical planters, project selected for the fall of 2014, provided the largest versatility. This project can be easily re-used since gardens reach a point of saturation where horizontal space is not longer available and the only way to increase production is by growing up.

Table 1: Engineering Projects for a Community Garden

Project Title	Description
Campus Rain Garden Design	A *rain garden* is a garden which takes advantage of rainfall and stormwater runoff in its design and plant selection. The purpose of this project is for students to determine the best space (or spaces) on campus for a rain garden, develop a design with the assistance of community experts and select native plants to be planted.
Rain water Collection	For each inch of rain that falls on 500 square feet of roof, it is possible to collect 300 gallons of water. This water can be used for house plants, gardens or even lawns. The purpose of this project is to construct a rain water collection system for a flat roof. Note that roof types will vary in other locations.
Trellis Design and Construction	The area where the garden is located has extra space that could include a trellis for plants that like to grow upward (i.e., hops, grapes, etc.). The purpose of the project is for students to determine the appropriate site for a trellis, the plants that would group best and design, build and install the trellis.
Vermicomposting prototype	Vermicomposting relies on worms to assist in the composting process. It is often more efficient than traditional types of composting. The purpose of this project is for students to design, build and test a vermicomposting prototype that could be used in the Gannon Garden.
Integrated Pest Management Guide	The purpose of this project is for students to work as a group in developing written guidelines for how to deal with pests in the Gannon Goodwill Garden. As part of this project, students will be required to research and determine the most common garden problems and develop some simple procedures for eradicating these problems that do not involve the use of chemicals or pesticides.
Vertical Planters	The purpose of this project is for students to design and construct a vertical planter for a fruit, vegetable or herb (of their choice) to supplement the current product at the garden.

Integration of Project in the Course

During a 16 week semester, six out of the 28 class meetings were dedicated to the project. The majority of the design meetings take place outside class time. Therefore, constant feedback and follow up is necessary to ensure the success of the process. Multidisciplinary teams of five-six students are created. Teams are required to submit three status reports leading to a written design proposal and a presentation before mid-semester break. The status reports, adapted from the EPICS program[8], guide the students through the design process. The status reports are the building blocks for a complete proposal. Table 2 presents the details of each status report. During the second half of the semester, the planter to be built is announced after receiving feedback from the stakeholders. All the teams are required to submit a re-design to improve the selected proposal. Construction tasks are divided amongst all teams with clear timeframes.

Table 2: Description of required submissions during the first-half of the semester

Reports	Topic	Content / Evidence
Status Report1	Specification Development	Description of context, mock-ups and simple prototypes, definition of user interaction, identification of other solutions and benchmarking, definition of customer requirements
Status Report 2	Conceptual Design	Brainstorm several possible solutions, prior artifacts research, prototypes with user feedback, feasibility of potential solutions, selection of "best" solution
Status Report 3	Detailed Design	Bottom-up development of components, design specification for components, schematics, exploration of failure modes
Proposal	Design Documentation	Project summary, detailed description of proposed design, schematics, methodology and timeline, budget, budget justification

Vertical Planters

Vertical gardens maximize the use of space amongst other benefits. The versatility of this project is that students are asked to select one produce that they will design for. Therefore, designs are specific to that produce allowing for a large array of ideas. Table 3 presents the constraints and requirements of the project. Five constraints were outlined in this project:

1. Select a fruit, vegetable or herb to grow. It must be suitable for Erie's climate.
2. Design must be specific for the selected produce
3. Maximize the yield of the produce
4. Maximum cost $150.00
5. Purchasing off-the-shelf product without any additional modifications is not acceptable. Modifications must be substantial.

The following requirements were stated during the project definition stage:

1. All levels of the vertical planter must be accessible with a 3' step stool for harvesting
2. Materials employed should be environmentally friendly

3. Employ recyclable materials for the structure to the largest possible extend
4. Easy installation and disassembly for future improvements or repairs
5. Two options for support: free standing, or placed against one of walls in the garden. Wall to be used must be specified.

Students selected a large number of produce to design for: tomatoes, pole beans, beets, green onions, chive onions, amongst others. Twelve designs were proposed and two were selected for construction. Figure 3 presents images of the herb tower and Figure 4 presents images of the tomato wall.

Figure 3: Herb tower (a) prototype, (b) installation, (c) final product

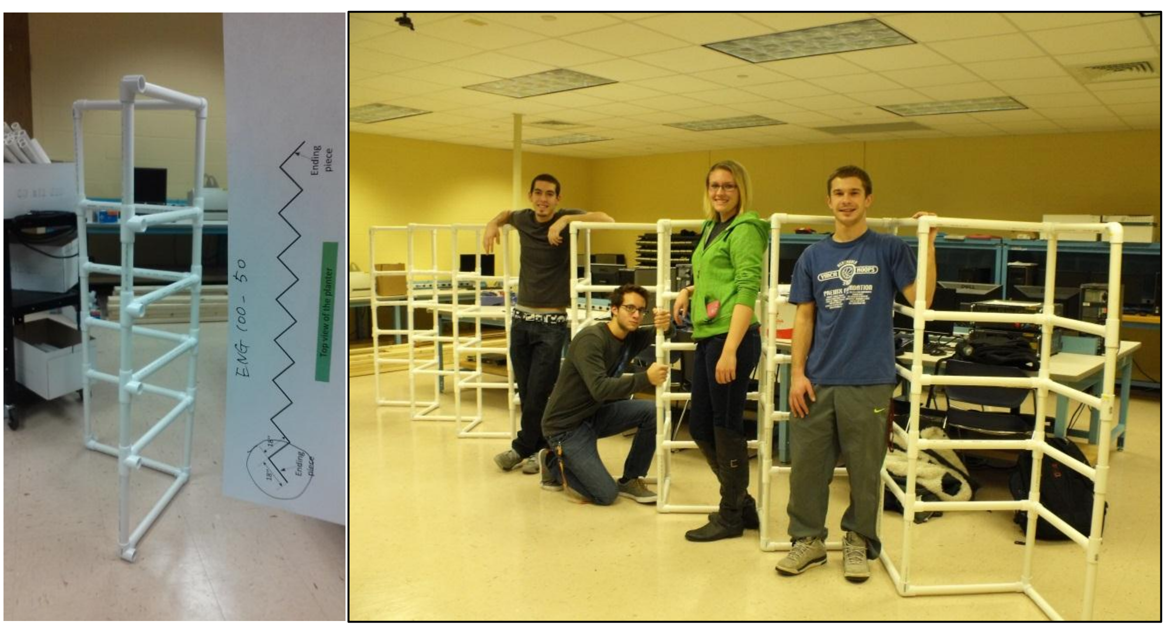

Figure 4: (a) Tomato wall segment with schematic, (b) Finished product

Lessons Learned

A survey (refer to Table 3) was administered at the end of the semester in addition to the course evaluation (refer to Table 4) to assess the impact of the community-based design project. The students' answers regarding their overall satisfaction and the awareness of the engineering design process correlate to their answers to the attainment of course outcomes. The questions categorized as "Service" (refer to Table 3) indicate that the students "mid-agree" that through the seminar they were able to understand the impact of engineering in the community, and that service is relevant. Table 4 presents the mean of the students' response to the outcome associated to the service learning experience; no significant changes have been observed since 2011 when the service learning projects were adopted.

Table 3: Fall of 2014 Survey Results Extract: *Engineering Environment and Students' Attitudes towards Service Learning*. Mean responses to Likert scale of 1 (Strongly agree) to 4 (neutral) to 7 (Strongly disagree), N = 33.

Overall, the seminar and its experiences…	**Category**	**Likert Scale**	**Mean**	**Standard Deviation**
… have allowed me to understand the impact of engineering solutions in a societal context	Service	Mid-Agree	2.50	1.6107
… have redefined engineering as a helping profession	Service	Mid-Agree	2.70	1.7385
… have improved my attitude towards community service	Service	Mid-Agree	2.83	1.7988

Table 4: Relevant Course Outcomes' mean responses to Likert scale of 5 (Strongly Agree) to 3 (Neutral) to 1 (Strongly Disagree).

Outcome	*Fall 2010_01 (19/22)*	*Fall 2010_02 (18/21)*	*Fall 2011_01 (23/24)*	*Fall 2011_02 (24/27)*	*Fall 2012 (51/58)*	*Fall 2013 (25/26)*	*Fall 2014_01 (33/33)*
7 - Demonstrate the ability to analyze what they learned from their engineering service learning experience	3.1	4.0	4.1	4.0	3.8	4.0	4.2
Overall were the course outcomes (1-9) achieved	3.5	4.0	4.0	3.9	3.9	4.1	4.1

The following list provides a guide for any faculty wishing to adapt this model to some degree.

- *Selection of the project is critical*. The scope of the project must possess the adequate level of complexity to challenge students and at the same time be feasible for a semester long course.

- *Clearly present the project and its community impact.* Students buy-in will make the semester long project more enjoyable and successful. Make the students care.
- *Ensure machine shop support for the freshmen.* Based on the different skills sets and the students' access to tools, it is important to coordinate machine shop support for those groups that need it.
- *Standardize the materials without eliminating the possibility of creative designs*. Create an online account that students can use to select their materials and save them in the shopping cart at Lowes or Home Depot.
- *Enroll upperclassmen to serve as managers*. The time required to oversee service-learning projects can overwhelm faculty especially in a course with a large enrollment. Upperclassmen can benefit from the interaction with freshmen; they can learn leadership and management skills form this experience. From the freshmen perspective, they can connect in a friendlier level with the upperclassmen. A mentoring relationship can develop which can have retention effects.

Conclusion

Urban gardens provide a wide variety of opportunities for engineers to not only improve their design and build skills but to develop their professional skills to levels not obtainable in the classroom. Engineering students involved in any aspect of these projects will walk away widened outlook on the impact of engineering. These projects provide many learning outcomes and address the social impact of engineering solutions early in the students' careers.

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