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Engagement in Practice: Using Community Engagement to Teach Drafting Software to Civil Engineering Students

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Abstract

This paper explores a course design that uses a software drafting program, Revit, as the foundation for community engagement (CE) projects in a required course for civil engineering students. Over four terms, this course has used seven CE projects with three different partners. Local community partners were found through the university's Center for Community Engagement who reached out to community partners that typically host placement-based CE in arts and sciences courses to find spatially based problems that students could address.

The course design included several sessions with the students and the community partners, including a preliminary kick-off meeting and a mid-term conceptual design review. After the conceptual design review, students developed several draft drawing sets and calculation documents, which were submitted to the professor as intermediate deliverables. Final drawing sets, calculations, and written explanations of the design were submitted to the professor and the community partner at the end of the quarter. Student teams also presented their work to the community partner. In addition to the final drawings and presentation, students were graded on an individual reflection paper about the design process and given peer evaluations to grade how the team worked together. Because drafting classes (e.g., AutoCAD, Revit, Solidworks) are common among many engineering disciplines, this approach is seen as a model of how CE may be incorporated easily into many engineering programs. In addition to explaining the course design, this paper presents summative reflections from the professor, a community partner, and the Center for Community Engagement coordinator about successes and failures with respect to these projects. These reflections are provided as learning opportunities to help others implement graphics-based CE projects. As a work in progress, this paper only addresses the course design and reflection on implementation and does not focus on student learning or perceptions.

Introduction

The literature is clear that active learning approaches are more effective at engaging students and promoting learning over traditional lecture style approaches[1]. Studies have shown that using active learning in the classroom increases student performance on concept inventories[2], increases student motivation in the topic area, improves professional skills development, and helps students connect course content to "real world" applications[3]. Project-based service-learning (PBSL) is a specific form of active learning that uses partnerships with community partners to focus the course project on contextualized problems that align with the mission or needs of the community partner. Community partners can be governmental or non-governmental agencies, communities, schools, or individuals. Generally these projects focus on addressing issues that affect marginalized communities. PBSL is a subset of educational approaches often called service-learning, learning through service, or community engagement (CE); all focused on increasing student learning through partnerships with communities while also benefitting the community[4].

Similar to active learning, studies have shown that PBSL in engineering correlates with increases in technical knowledge[5], professional skills such as teamwork, communication, and leadership[6], and increased views of social responsibility[7]. Additionally, PBSL as a way to use engineering to help others may be more attractive to women and underrepresented minority

students, helping to attract and retain a more diverse student body in engineering[8-10]. In the context of this course, PBSL was used to help show students that engineering can be used to help others in direct ways and that there are many local opportunities to have positive impacts with the skills that they are learning as engineering students. The following section presents the course design and describes the projects and community partners that have been used.

Course Context and CE Design

These CE projects were implemented into a required sophomore level civil engineering course focused on introducing students to building codes, load paths, and Revit, a three-dimensional drafting tool used primarily for buildings. The course taught these topics concurrently, with two lectures a week designated for building code and design topics and one lecture each week focused on the drafting software. The projects allowed the two disparate elements of the course (building design and drafting tools) to be combined. The course learning objectives related to the term project focused on 1) an ability to navigate the building code, 2) to develop models in Revit, 3) to work effectively in teams, and 4) to effectively communicate engineering designs through drawings and text to engineering and non-engineering audiences. These learning objectives helped to guide the project development and grading.

Each project was designed to span the entire term (11-week quarter) with students working in teams of two to four. A rough timeline of the project including tasks and goals for each task is provided in Table 1. Activities such as the kick-off meeting, the memorandum of understanding and the conceptual design meeting, where students presented their initial ideas to the client and received feedback, were designed to increase collaboration between the students and the community partners and to help students gain a respect for the diverse experiences and knowledges that the community partners brought to the projects. These activities, ideally, helped to promote mutual benefit for both the students and the community partners as a transactional form of CE[11] and to avoid many of the exploitative practices seen in other CE projects[12].

Table 1. Community engagement project tasks, timeline and purpose or goals

Task/Deliverable	Timeline	Purpose/Goal
Project Kick-off	Wk. 1/2	Introduce students to project and meet community partner
Memorandum of Understanding	Due Wk. 3	Expose students to formal agreements and set expectations for communication and collaboration with community partner
Site visits	Wks. 2-5	Students visit site to take measurements necessary outside of class time
Conceptual Design	Due Wk. 5	Students discuss initial design ideas with community partner, receive feedback, and adjusts design as necessary based on partner feedback
1st Draft Drawing Set	Due Wk. 8	Early deadlines distribute work across several weeks, curbing procrastination of the entire deliverable
2nd Draft Drawing Set	Due Wk. 9	Encourages students to address faculty comments on initial draft drawings. Improves quality before going out to community clients
Final Drawing Set,	Due Wk. 11	
Final Presentation to Community Partner		Allows students to share their work and also practice speaking to non-engineering audiences about engineering work
Peer Teamwork Evaluation		A self and peer evaluation of teamwork and project contribution
Individual Reflection Paper		Guide students in a reflection on what they learned from this project, how the project is and is not representative of engineering work they expect to do upon graduation, how the specific context of the project affected their design, and what they would change if they were to do this project again.

Deliverables were spread throughout the quarter to break the project into smaller, more manageable pieces and to curb, or at least distribute, procrastination. All deliverables were graded using rubrics shared with the students beforehand and the project contributed to 25% of the students' total grade in the course.

Table 2 summarizes the community partners, projects, team sizes and deliverables that have been used in this course. These are provided to give examples of the types of project that have been done using drafting-based engineering software.

Table 2. Description of CE partners, projects and deliverables

Community Partner	Project	Teams	Deliverable
Local soup kitchen	Design new pantry space	3 teams of 3 each	Drawings of existing and redesigned space and cost estimate
Regional faith-based organization focused on housing, jobs and other social services for vulnerable communities	Layout redesign for a large shared office space that functions as interview space for clients, work space for interns, and meeting space for employees and volunteers	2 teams of 2 each	Drawings of existing and redesigned space and cost estimate
Local non-profit working to empower regional Latino communities	Redesign of a 3000 square foot basement of a 1910s school to serve as a senior center, soup kitchen, and licensed kitchen for entrepreneurial ventures	3 teams of 3 each	Drawings of existing and redesigned basement. 1 group did existing, while 2 groups did revised plans.
Live-in community for adults with developmental disabilities	New exterior fire-escape staircase design for 3-story home	2 teams of 3 each	Drawings, structural design, and cost estimate for revised fire-escape stairway.
	Kitchen renovation, 1 plan with existing footprint and 1 plan with a 10 foot addition	2 teams of 3 each	Drawings of existing and redesigned kitchen
	Basement renovation	1 team of 3	Drawings of existing and redesigned basement space
	Stand-alone workshop conceptual design	1 team of 3, 1 team of 4	Description of code restrictions for a stand-alone structure on their property and preliminary space design

Reflections on Projects

The following sections provide reflections from the various parties involved in the design and execution of these CE projects including 1) the professor, 2) the community partner from the local soup kitchen, and 3) the staff member at the university's Center for Community Engagement (CCE) who helped facilitate each project.

Faculty Reflection

In general, using these projects in my course has required that I be more flexible with my schedule. Over several iterations, I have reduced the number of homework assignments, especially in the last three weeks of the course, to give students more time to work on their projects. I have also added one or two in-class work periods where student groups can work with me there as a resource and to give instant feedback. In order to keep a pulse on the class throughout the quarter, students turn in weekly timesheets so that I can see how much time the project is requiring compared to their homework and studying. Using these data I can add in-

class work sessions or reduce the project scope if students seemed overwhelmed. On several occasions we have also adjusted the scope of student work as the community partner shifted their expectations. From my perspective, this can be an important learning experience for the students to see that they also need to be flexible as engineers since most projects shift and adjust in consulting work as well.

Initially, the majority of the student feedback on the projects focused solely on the amount time that these open-ended problems required, leading generally to lower course evaluations. I have tried to use the student reflection assignments at the end of the project to push students to see the potential benefits of the project, beyond just the amount of time they spend. Since I've provided more structured reflection prompts, the formal course evaluations have gone up and students seem to look more holistically at the costs and benefits of their involvement in the projects. The use of timesheets has also helped me to open discussions with the students of time expectations for the course.

Finally, using real problems with a strong social context is more interesting for me. Each quarter there is something new for me to learn and a problems to work through. I feel that fostering a connection between the students and the community partner helps to motivate the students. To help foster this, I have asked students to volunteer or join in community events outside of class to learn more about the mission of their partner.

Community Partner Reflection

Working with project-based service-learners has been a positive experience for our soup kitchen program because these projects have the potential to help us in our daily operations. The demands of operating a soup kitchen and getting funds to make improvements are always a challenge. While our program includes placement-based service learning students who volunteer weekly, the PBSL students that we worked with only volunteering with the kitchen for one day. While brief, this still provided the students an opportunity to learn how to interact with others in an environment that was likely largely unfamiliar. The students expressed how they enjoy volunteering in our kitchen because they gained insights into our needs by seeing the kitchen in action.

I was connected to this project through the university's Center for Community Engagement, who I often work with for placement-based service-learning. They asked if our kitchen needed help with storage or space planning. Because our program involves storing and using large amounts of food supplies and the design was free to our program, this seemed to fit well with our needs and capacity. Providing students with an opportunity to gain professional experience by working with us was also important.

We asked the students to design a new pantry storage and coffee service counter for our kitchen. With nine students working on the project, we formed three groups of three students for diversity in the solution and to minimize the interaction time between students and the soup kitchen staff by having a contact leader for each group. The students did an excellent job listening to our needs and observing how our space was utilized when they volunteered in our kitchen. In the end, they collectively presented three very different, yet professional and useable designs. While we have not been able to implement their ideas yet, we continue to consider them in our pantry storage planning.

After working with the students and reflecting, I realized it would have been helpful to schedule more time with our staff and ongoing volunteers to explain how PBSL works. Our regular volunteers spend a lot of time and effort training service-learning students and some of them became frustrated after these students only came once to volunteer and then, seemingly, disappeared. Additionally, finding uninterruptable time to meet with the students about the project was difficult. There are two ways the interactions with the students could be improved. First, on the kitchen side, I would delegate operations of the kitchen to avoid interruptions while meeting with the students about the project. Second, I would make clear to the students that if they arrived early to meet or came late, I may not be able to respond to their questions or ideas with the necessary focus. This is because our soup kitchen program can appear spontaneous and informal, yet its operations are complex that often require immediate attention. Overall, working with project-based service-learner students has been a positive experience and we would include them in our soup kitchen program if asked again.

Center for Community Engagement Reflection

Project-based courses require students to apply advanced skills to a problem under the expert guidance of a faculty member; however, it's hard to identify projects that provide the right amount of challenge for students and are achievable in a single term. It was also initially quite difficult to find projects for this course because I didn't have a clear idea of exactly what the students could do. With no background in engineering I relied heavily on the professor to meet with the community partners to talk the projects over. After attending the students' final presentations, I learned what they were capable of and it became much easier to recruit new community partners.

I think the kitchen project was successful largely because the instructor was personally committed to the organization (he had served as a volunteer cook there for several years) and because the kitchen director took a genuine interest in what the students were learning. Their good relationship led to great communication early on, which made the project run smoothly. In contrast, a later project which lacked this foundation was more frustrating for the instructor and students. Although well-intentioned, this later partner was less responsive to emails and phone calls and occasionally missed meetings, which made for a much more stressful quarter for the instructor. Going forward, I encourage faculty members to spend time on site before the project begins, and I'm more explicit with community partners about expectations for their involvement.

Our approach in the Center for Community Engagement is to develop sustained relationships with faculty members and community partners because working together over time enhances both student learning and community outcomes. However, most agencies don't need new drawings every year, so we have had to work with new partners each time. In almost every case, however, the community partner has a sustained relationship with university students who are providing direct services quarter after quarter. Although the engineering project is a one-off, we see projects like this as a way of offering valuable, capacity-building support to our community partners.

Conclusion

This paper has presented one way in which CE projects can be incorporated into engineering courses that teach drafting tools such as Revit, AutoCAD or Solidworks. Using CE projects as a vehicle for meaningful, contextualized projects in this drafting class has been fruitful for the faculty, community partners and, based on student reflections, for students as

well. Over several iterations, the course design has been adjusted to spread out deliverables to curb procrastination and to provide structured reflections for students in the hope of helping students to fully realize the benefits that have been shown to exist with PBSL in engineering. Two challenges with using PBSL in these context is the need to find many community partners who need drafting services, especially to repeat the use of PBSL over several terms. Communication expectations between faculty members, students, and community partners has also been a challenge that has been negotiated and renegotiated with each iteration. Finally, partnering with the university's Center for Community Engagement has been central in finding projects and also in allowing short term project collaborations between the university and the community partners, while retaining longer term relationships through placement-based service-learning used in other classes. Future work will build on this paper, focusing on student perceptions of the projects, perceptions of learning and performance on assessments related to learning the software.

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