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SERVICE LEARNING FOR SUSTAINABILITY: IDEALS TO PRACTICE

APRENDIENDO SOSTENIBILIDAD MEDIANTE TRABAJO COMUNITARIO: DEL IDEAL A LA PRÁCTICA

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Abstract

Community-based service learning is used in engineering and construction curricula to engage students in interesting, complex problems that benefit the community while developing competencies essential to professional practice. Service learning projects effectively expose students to issues otherwise difficult to teach, including critical resource constraints, tactics to overcome them, tradeoffs among possible solutions, systems integration, and organizational challenges of implementation. However, they are often underutilized due to the risks and challenges of integrating them into classes and managing student involvement. This paper explores the questions of what makes CBSL projects successful and the challenges faced by both faculty and students who participate in them. The findings are based on a literature analysis of challenges and a review of two service learning projects implemented by a conjoint senior level/graduate class on sustainable facility systems at Virginia Tech. Lessons learned are identified in three key areas: design as listening vs. design as inspiration, conflicting and unspoken objectives, and construction realities. Service learning projects offer a secure environment in which to learn about the challenges of construction, where the unexpected is an expected and valued part of learning. Through these experiences, students can better understand the tradeoffs required to pursue sustainability in capital projects and can better place sustainability objectives such as "minimize waste" and "reuse construction materials" in the context of what these objectives require in practice. These projects also offer benefits to clients in the community and afford the opportunity for civic engagement by students that may carry forward into their lives after graduation.

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Introduction

Service learning is a style of education in which students have the opportunity to practice their professional skills in a real world context, to benefit real world stakeholders. Unlike typical classroom exercises, students engage with real clients about the challenges they face, and must find solutions that fit within the constraints those clients impose. While students often enjoy these experiences of hands-on learning, they sometimes also undergo frustration as a result of the difference between expected and actual experiences in the project. This paper describes some of the service learning activities as part of sustainable construction education at Virginia Tech where key learning experiences have taken place as students serve their community while putting their theoretical skills into practice.

Service learning is a style of education in which students have the opportunity to practice their professional skills in a real world context

Background: The Challenges of Service Learning

Community service projects are a natural component of civil engineering and construction education programs, largely because of the public service orientation of their respective professions. Many students love to get out of the traditional classroom working with their hands and minds to solve real problems and/or build something meaningful. The concept of service learning builds on this tendency, adding explicitly-stated and assessed educational components to create a broader beneficial learning experience. It is not just a recently developed pedagogical approach, having "modern" roots in the social activism of the 1960s, followed by community service for democracy and citizenship in the 1970s and 80s, and finally as an educational tool beginning in the 1990s (Barlow 2009). Now, many educational practitioners understand that learning through service can be very effective, providing students with opportunities to develop professional and independent learning skills as well. In fact, service learning is one of the four emerging trends in engineering capstone courses, along with technology, multidisciplinary projects and principles of sustainability (Scott Stanford et al. 2010).

This paper describes some of the service learning activities as part of sustainable construction education at Virginia Tech

The body of knowledge for implementation of service learning projects in construction and engineering sustainability is growing steadily (Pearce and Manion 2016). Cline and Kroth (2008) have identified the following attributes of a good service learning project:

1. Allow learners to practice construction management academic (and sustainability) skills learned in the classroom using real-life experiential learning;
2. Provide an opportunity for learners to interact with project recipients;
3. Be feasible, considering the amount of time available;
4. Be complex enough to allow learners to be challenged, but not overwhelmed;
5. Contain an element that will allow for learning through reflection;
6. Evaluate the relative success of the project and the effect of the experiential learning process.

Finding projects that meet these criteria can be challenging, although the number of efforts to include service learning as documented in the literature continues to grow. Even after a suitable project has been identified, many other challenges still plague faculty who wish to include service learning in their curricula (Table 1).

The focus on challenges of service learning in the literature has been largely from a faculty standpoint, but the specific challenges they bring to the forefront for students involved in these activities is less documented. What special challenges do students face in design-build service learning projects for sustainability? How do those challenges enrich their learning beyond conventional classroom activities?

Learning Opportunities in Sustainable Construction

When undertaking design-build service learning courses with a goal of improving sustainability, students have opportunities for learning about the challenges of sustainability implementation in ways that are otherwise very difficult to learn in the classroom. The remainder of this paper describes challenges faced by students participating in two service learning projects as part of a conjoint sustainable construction class at Virginia Tech during spring semester 2016. Conjoint courses at Virginia Tech involve shared learning experiences among two different levels of students (typically graduate and undergraduate).

Table 1: Challenges of Incorporating Service Learning
in Sustainable Design and Construction Courses

	Anderson 2007	Barlow 2009	Batie 2007	Bernstein 2006	Bielefeldt 2010	Burr & Martin 2003	Clevenger & Ozbek 2013	Cline et al. 2014	Davis & Cline 2009	Lens & Dewoolkar 2015	Pearce & Manion 2016	Scott Stanford et al. 2013	Steinemann 2003	Tinker & Tramel 2002
Design of suitable and feasible projects					x						x		x	
Student mediocrity, lack of commitment/follow through, and waning enthusiasm	x										x		x	
Less-than-professional construction workmanship and designs	x						x			x	x			x
Risk of being mistakenly identified as a vocational program									x					
Faculty and student workload, particularly on weekends for hands-on projects								x			x	x		x
Increased time for course preparation, delivery, and evaluation											x		x	
Finding time for reflection and implementation during project completion		x											x	x
Non-traditional assessment and grading techniques						x		x					x	
Construction safety and institutional liability		x	x	x			x	x		x	x			x
Negative student perceptions of a lack of traditional course structure							x							
Balance between instruction and students' agency to run their own projects											x		x	
Conflicts between stakeholder opinions and good sustainability practices											x		x	

The learning objectives for both BC 4334, Sustainable Building Performance Management (senior undergraduates) and BC 5134, Sustainable Facility Systems (graduate students) are to empower students to:

- Identify a range of feasible and contextually appropriate best practices for improving the sustainability of a built facility through multiple phases of its life cycle.
- Evaluate and compare these practices in terms of their relative performance according to traditional qualitative and quantitative criteria such as first- and life

cycle cost, performance, time, and quality, and in terms of their relative impacts on facility sustainability.

• Design a recommended course of action to increase the sustainability of a facility that takes into account the context of implementation.

• Support recommendations with convincing evidence and well-organized analysis delivered in a professional fashion, and plan their implementation.

• Predict likely impacts of implementing those recommendations on specific projects in terms of project sustainability.

Given the orientation of learning objectives around recommendations appropriate for specific situations, working with real projects seemed a natural fit. The combined class size was sixteen students, equally divided between fourth year undergraduates in the Sustainable Performance and Energy Management track of the B.S. Building Construction degree and graduate students at the M.S. and Ph.D. levels in disciplines including Civil Engineering, Building Construction, Environmental Design and Planning, and Architecture.

In previous iterations of these courses, the project deliverables were reports and presentations, and sometimes prototypes. However, in the 2015 conjoint offering of the course, the instructor elected to engage students with two real projects involving local organizations as a means of increasing the impact of learning for students while enhancing outreach and contributions to the local community. Two projects were selected with the aim of having comparable scope. The first project (Figure 1) involved designing and constructing a conference room made entirely of reused materials inside the local Habitat for Humanity ReStore, to be used for board meetings and confidential meetings with potential Habitat homeowners. The second project (Figure 2) was the design and construction of a day room at a local municipal animal shelter for resident cats (the PantherHouse) to have the opportunity to exercise outside their cages and interact more naturally with potential adopters. Both organizations had previously been engaged with students from the School of Construction on projects, and in both cases, the organizations themselves suggested the project as being a priority for meeting current needs.

Figure 1: Habitat for Humanity ReStore Conference Room

Projects were developed through a sequence of four major phases, including definition of requirements; design; construction, and reflection. In addition to internal deliverables developed by each team to document their work for a course grade, teams also conducted regular feedback cycles with their clients to ensure that their solutions met client goals and requirements. In addition to developing a design solution that met client goals, objectives, and constraints, students also had to develop an implementation plan for the project that could be completed with available resources and skills, within the operational constraints and challenges posed by the client organization. These constraints included significant limitations on the timing of work, thus reducing the envelope for construction to a very limited period of time in the second half of the semester. Ultimately, one team was able to complete their project, while the other team was not. Three key lessons were identified as a result of these projects, as follows.

Figure 2: Radford Animal Shelter PantherHouse

Design as Listening vs. Design as Inspiration

The iterative, client-centered design process used to structure the project required students to consider the process of design differently than a designer-centric design process. Rather than produce a design "inside their own heads" that they would then try to persuade the client to adopt, the teams were stepped through distinct cycles of client input followed by ideation followed by client feedback to ensure that their designs met all objectives and constraints of the client. During ideation, teams were introduced to processes such as structured brainstorming that encouraged them to conceptualize and develop ideas that were outside what clients would find acceptable. These solutions were then explored and captured as part of a range of design scenarios to be presented to the client for review, which enabled clients to more clearly articulate what they liked and did not like about each design scenario. This process of presenting options as part of a range of possible solutions rather than a single, stand-alone idea enabled students to remain client-centered and focus on the client's reactions and choices from multiple possibilities, rather than becoming over-invested in a single concept of their own choosing. As such, students became aware that design for sustainability is about finding options that are a good fit for the client through an iterative process, rather than a mysterious process of inspiration where a fully-formed idea is presented to a client to accept.

Requirements Definition: Conflicting and Unspoken Objectives

Student involvement in the requirements definition phase of the work also exposed them to the challenges faced by clients in clearly articulating objectives and constraints. Particularly with clients who are not familiar with capital projects, a client's vision for the end result may be far beyond what can be reasonably achieved with the resources at hand. A key role of the design team is to help clients understand and reconcile their vision with what is possible, given the resources and other constraints available to the project. Clients may also hold unspoken objectives that are not well-understood until the design team presents ideas that are not attractive to the client, even though the client may not be able to articulate why that is the case. Presenting a range of ideas helps the design team identify these unspoken objectives and verify them with the client without feeling threatened by a client's response to any one concept. Finally, client choices sometimes clearly conflict with sustainability goals for the project, particularly if sustainability was not the dominant reason for the project in the first place. When faced with the challenge of taking a project from requirements definition through design and implementation, students must learn the art of compromise.

Incorporating sustainability as a driving design objective was a serious challenge in both projects, as it often is in professionally-led projects. The common overriding desire is to complete the project successfully, putting pressure on participants to make tradeoffs between scope and sustainability. Unfortunately, with time-constrained project delivery of one semester, scope often wins, as identified by students' reflections at the end of the semester. Students also realized how difficult it is to manage every aspect of sustainability in a project. For example, in the Habitat project, the Habitat project manager procured standard construction materials, paying no attention to students' requests for more sustainable products or more alternatives not explicitly specified by the students.

From a design standpoint, Habitat had a preconceived notion of how the wall system for the conference room should be built and elected to revert to that notion despite less resource-intensive and more sustainable options proposed by the students. Likewise, although the animal control officer agreed in principle to sustainability as an objective in the PantherHouse project, interior finishes were ultimately constrained by what the state inspector would approve as an acceptable surface for contact with animals. The opportunity to communicate interactively with state inspection officials was not forthcoming, so material specifications for interior finishes were made based on affordability and sanitizability, even though this resulted in the use of products that did not meet sustainability goals. Ultimately, by following a project through completion, students have the opportunity to learn about the tradeoffs that must be made among complex and competing objectives for sustainable projects.

Construction Realities

Finally, being responsible for planning and implementing the construction phase of a project introduces students to challenges that they will regularly face in their professional lives in the construction industry, as well as giving them a perspective on other key stakeholder roles necessary for the construction of capital projects. In design-build service learning, students play both a project management as well as a craft worker role, since they must both plan and actually execute the work.

The level of construction experience in any given class may be highly variable, with students having different types field internship experiences, experiences working in a trade, or even do-it-yourself experiences. Likewise, levels of academic experience and training may also vary, as was the case with our conjoint class a Virginia Tech. This means that while most students had at least basic estimating skills and experience, few had the holistic experience of actually creating a purchase list of all the components required for construction of an actual project. For example, students knew how to estimate the total area of wall coverings required for the PantherHouse exterior, but did not realize all the elements that had to be purchased to construct it, such as staples to attach the housewrap, tape for the seams, and flashing for the base. This was also the first exposure some students had to the challenge of minimizing seams and optimizing cuts in sheet materials for the exterior wall. Most students in the sustainability class understood and endorsed the idea of minimizing waste during the construction process, but until they had to actually put together the exterior wall covering of a structure, they did not understand how material waste might trade off for labor costs or product quality in assembling a drainage plane with a minimum of seams.

Students also had the opportunity in both projects to experience the challenges of field adjustments to account for imprecision in existing buildings and construction materials. The ReStore conference room was constructed inside an existing tenant area of a strip mall that did not have plumb walls, and the structural frame constructed by the students had to be adjusted to account for this during the assembly process. In a similar vein, students used locally manufactured Structural Insulated Panels (SIPs) to construct the PantherHouse enclosure, and they learned the challenges of using typical dimensional lumber with tight tolerances when the available lumber was warped or had other deficiencies. The aim of both projects was to incorporate reused materials wherever possible as part of the design, and students quickly learned that such materials are not always perfectly plumb and square or structurally predictable. For example, the PantherHouse made extensive use of vinyl replacement windows recovered from a local apartment complex that had been demolished. While these windows were available for free, they required significant extra labor to clean prior to installation, and some seals were broken that resulted in condensation between the glass panes after installation. The replacement windows also came without nailing fins or flashing, meaning that each window opening had to be carefully detailed and flashed to prevent water from entering the building envelope. None of these issues would have arisen if using new windows for the project.

Conclusions: Service Learning for Sustainability

Employing service learning as a pedagogical approach in classes on sustainable design and construction offers both challenges and opportunities compared to other types of pedagogy. While many challenges have been identified with this approach from the standpoint of faculty who teach the courses, less attention has been paid to the challenges faced by students taking the courses and the learning opportunities these challenges provide. This paper explored three categories of challenges – design as listening vs. design as inspiration, conflicting and unspoken objectives, and construction realities – that emerged for students undertaking one of two service learning projects in a conjoint sustainable construction course during spring semester 2015 at Virginia Tech. Service learning projects offer a secure environment in which to learn about the challenges of construction, where the unexpected is an expected and valued part of learning. Through these experiences, students can better understand the tradeoffs required to pursue sustainability in capital projects

and can better place sustainability objectives such as "minimize waste" and "reuse construction materials" in the context of what these objectives require in practice. These projects also offer benefits to clients in the community and afford the opportunity for civic engagement by students that may carry forward into their lives after graduation.

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