Community-Based, Service Learning Approach to Teaching Site Remediation Design

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Abstract

A common difficulty in teaching environmental site remediation is how to consider both hard and soft constraints in course design, in a fashion that leads to students being able to drill down to the core of problem and formulate their design accordingly. This paper describes how hard and soft constraints were addressed in engineering design using community-based, service learning (CSL) design projects. In the site remediation course at Tufts University, three design projects required the development of a remediation scheme for actual brownfield sites in Boston, MA. In their designs, students had to consider both hard (limited and conflicting contaminant information for site soil and groundwater) and soft (the viewpoints of the various community stakeholders) constraints.

Based on student, faculty and staff feedback, the design experience carried more meaning and encouraged greater learning because it involved a real problem. Additionally, the experience extended student learning beyond the technical aspects of site remediation as a result of working and interfacing with people from a variety of interests and professional backgrounds. By including service learning in the course design project, the students then had a dual vehicle in which to refine their designs in ways that deepened their understanding and learning. From our experience overseeing this course, we conclude that to truly realize the benefits of service learning, integration of CSL throughout the curriculum is needed along with better management of service learning components.

I. Introduction

Site remediation, as a profession, requires a broad range of technical expertise including, but not limited to engineering (civil, mechanical, chemical, and electrical); natural sciences (geology, hydrogeology, chemistry, physics, and biology); advanced sciences (microbiology, geochemistry, toxicology, etc.) and engineering management. At Tufts University, a course entitled Site Remediation Techniques is offered through the department of Civil and Environmental Engineering and serves as one of the design electives in the department's Accreditation Board of Engineering and Technology (ABET) accredited bachelor of science degrees in civil engineering (BSCE) and environmental engineering (BSEvE). With to respect to ABET 2000 criteria, the course objectives are to present the design aspects of various remediation technologies used for cleaning up sites with contaminated soil/sediment and/or groundwater and to technically prepare students for the practice of site remediation.

Typically, the course consists of homework assignments, mid-term and final exams, and a design project. The design project, an open-ended problem that requires students to design a remediation scheme for a contaminated site, constitutes 40% of the course grade and requires the most significant student effort in the course. The objective of the projects was for the students to address the technical or hard constraints of remediating sites such as how to handle the limited amount of available data or what was the most appropriate type of treatment to employ. In the past, all students would address the same site: either an actual site with the scope of the problem more narrowly focused for the time frame of the course or a scenario developed by the instructor to present the technical challenges involved with cleaning-up contaminated soils and groundwater.

Recently, the authors incorporated community-based service learning (CSL) components into the design project to enhance the students learning objectives in two ways. First, the students now must address both technical and non-technical constraints in their remediation designs. Second, the students would act as "technical liaisons" in the remediation process in that they would need to interact with the actual stakeholders (community, developers, regulators, etc.) involved in the re-development of abandoned, yet desirable, real estate. The projects were still open-ended, but required the students to develop real solutions to real problems.

This paper describes the development, implementation and evaluation of the CSL activities and how they were imbedded into and influenced the outcome of the course. Specifically, this paper describes how engineering design and CSL activities were combined for three design projects. Each project required the development of appropriate remedial strategies for small, urban brownfield sites in Boston, MA that were undergoing or needed to undergo remediation. engineering design using CSL design projects. First, the paper defines community-based SL and how to establish community-university collaborations for curricular development. The paper then describes the assessment tools that were used to measure the effectiveness of CSL projects in fulfilling design objectives and outcomes of the ABET 2000 criteria. The three design projects developed to address the remediation of actual brownfield sites in Boston, MA are presented with both the hard (technical) and soft (non-technical) constraint detailed. Finally, the paper discusses the results of the projects, the student and instructors faculty and A comparison with design projects without community-based SL is also presented.

II. Community Based Service Learning Methodology

Community based service learning can be seen as an approach to integrate academic learning into the community. In doing so, this completes the educational process and contributes to the mission of Tufts University to provide "to undergraduate, graduate and professional students a rigorous education that provides knowledge and skills for them to grow as intellectually curious and critically involved *members of society,* with a lifelong commitment to learning."

To orient the students to the concept of service learning, the following model, shown in Figure 1, was introduced to the students and reinforced throughout the semester. Since the majority of Tufts students come from non-urban areas, a physical tour was given to point out pertinent aspects of the community in which the students would be working. The students are encouraged to process these aspects as they look for and formulate hard and soft constraints that will govern their site remediation design. As the students are participate in the service learning activity they are asked to compare (differentiate) what they are experiencing with what they expected. The hope is that the output of this process refocuses the student learning on pertinent aspects of the project as well as develops new behavior derived from the learning process.

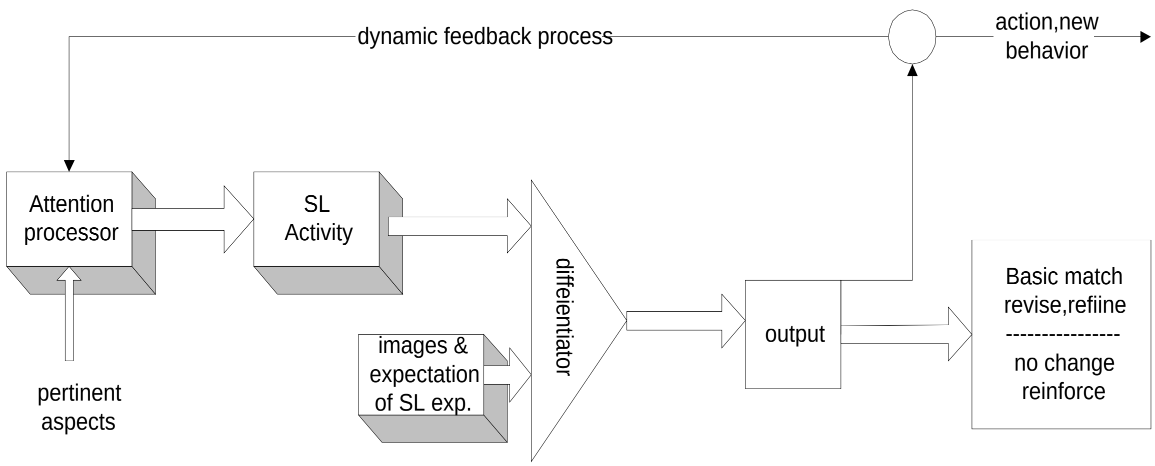

Figure 1 Service Learning Model

To truly implement CSL in an academic setting requires the establishment of collaborative relationships with community partners. Two things must be satisfied to establish such a relationship; meeting academic learning objectives and satisfying community service needs. Once a basic match is established, it becomes a matter of meshing the operations of the respective organizations. Here is where the partnership becomes problematic. It is easy enough for the community partner to understand and appreciate how the university works, but the university is often slow to appreciate how the particular community organization works. Community organizations are typically understaffed and overworked. Community organizations work towards end goals, such as environmental justice or economic development. Thus, while site remediation may be a service need, what is really desired is site remediation that leads to achievement of final goals. Example final goals could include environmental justice that may include proper punishment for violators, adequate funds for proper clean up, and appropriate measures for future environmental protection. Clearly, a single semester course on Site Remediation can not cover all these aspects. Thus, to form truly collaborative relationships, the service must be bridge across the various academic disciplines of the university and the service must be maintained continuously.

III. Structure of Assessment Tools

Student assessment tools can be placed in two categories: 1) graded project requirements in terms of scheduled deliverables; and 2) personal journals and discussions within design groups and with stakeholders. These assessment tools as a whole not only provided a way to assess the students' performance in the CSL projects, but also provided a means to assess the success, or failure, of CSL projects in affecting students' learning.

A. Graded Project Deliverables

The following deliverables were required from each group: group journal entries, project status reports, oral presentations, and a final report. These deliverables were mandatory and served as the graded elements of the project component of the course. Table 1 shows the schedule of project deliverables.

Group Journal: The group journal, updated weekly, documented group activities during the project. The journal contained not only a summary of the work performed but also a listing of desired deliverables and the expected and actual date of completion; sources of information (bibliography); and external and internal (to Tufts) contacts (when made and information gained). These journals were submitted bi-weekly for review by the instructor.

Project Status Reports: Two status reports were required during the semester. These reports were 2-page memorandums detailing what each group had done and what they will be doing with regard to the project.

Oral Presentations: Groups were required to present two oral presentations during the course. The first presentation, 10 to 15 minutes in length at the 4-week point, was introductory, describing the project and the scope of work to be performed. The second presentation occurred at the end of the semester and presented the results of the students' work. Presentations were videotaped for additional evaluation and course records.

Project Final Report: Each group will produce a final report detailing the design and analysis of the remediation strategy(s) that were evaluated. The main body of the report will be no more than 25, double-spaced pages (12-point font size) in length. Appendices containing detailed computations and supplemental data/records are encouraged.

Table 1
Summary of Deliverables and Project Schedule

	Deliverables Due During					
	Week 3	Week 5	Week 7	Week 9	Week 11	Week 12
Oral Presentation 1		✓				
Group Journal	✓	✓	✓	✓		
Project Status Reports		✓			✓	
Oral Presentation 2					✓	
Final Report						✓

B. Personal Log Book

Personal notebooks were to be kept by each student and intended solely as an evaluation tool for the effectiveness of CSL projects. It consisted of monthly entries by the each person involved with the project stating the objectives and goals of the project and how they are being met. As a guide, students were to receive written questions regarding the expectations of the project and how these expectations are/are not being met. Observations were to be frank and constructive. The log books were not to be read by the instructor until after grades were finalized.

Three groups of 4 to 6 students were developed with each group required to evaluate, design and recommend specific site remediation techniques for their site. Groups had 10 weeks to complete their projects.

IV. Project Site Description and Data

Project sites included two former industrial sites (Former Modern Electroplating and Hawthorne Associates sites) and a residential site contaminated by lead-contaminated fill materials (Washington Beech housing site). All sites had soil and/or groundwater contamination issues to address, and, by their very nature, presented both hard and soft constraints that required the students to tailor and optimize their remediation strategy. Typically, the course attracts engineering seniors and full-time and part-time graduate students from an array of disciplines creating a unique class with a broad range of interests and skills. However, for these projects, groups were allowed to select their own members, and, thus, groups tended to contain members with similar education, interest, and/or experience.

Project information given to each group included the site's location, former uses, types and concentrations of contaminants of concern, available engineering investigation reports, and the site's possible end-use after remediation. In addition, the groups were given the names of stakeholders involved with the site including relevant government offices and departments, community groups, regulatory agencies and potential site re-developers. As an example of this data, Table 2 shows a summary of data available for the former Modern Electroplating site.

Note in Table 2 the multiple end use choices in the former Modern Electroplating site, This lack of specificity in what is the site's final end-use proved to be the most influential soft constraints on design. This lead to students creating a number of different remediation schemes to fit into the possible end-use scenarios for the site, increasing the work load associated the project.

As stated earlier, students made site visits to initiate the development of design options. For their technical evaluations, students were required to research remediation technologies beyond those presented in class notes. Additional sources of information included design guides, nomographs, and professional contacts in the remediation practice. The use of commercially-available computer programs in evaluating site exploration data or potential remediation strategies was also encouraged.

The two major constraints on the projects involved 1) the lack of technical information, especially chemical data, and 2) limited contact with site stakeholders. The lack of technical data represented the most difficult hard constraint for the projects. However, this lack of environmental data was expected given the scarcity in funds available for investigating these small sites. In fact, the data presented to the groups was all that could be found from regulators, community groups and/or state office holders. Contacts with and questions for site stakeholders were first directed to the course TA who would then contact the appropriate stakeholder. The limited stakeholder contact was imposed by the instructor as a mechanism to prevent inadvertent "badgering" of stakeholders; especially site owners/redevelopers who may wish to remain "behind the scenes". Both of these constraints forced the students to manage the available information in a fashion similar to practicing engineers.

Table 2
Summary of Data Given to Student Group

Name:	Former Modern Electroplating
Location:	2430 Washington Street, Roxbury (Boston), MA
Community Group:	Dudley Street Neighborhood Initiative (DSNI)
Community Group: (Legal support)	Alternatives for Community and Environment (ACE):
City of Boston:	Boston Redevelopment Authority
State:	Massachusetts Department of Environmental Protection (DEP) Attorney General's Office
Potential Developer:	Boston Redevelopment Authority
Former usage and history of the site:	The site had been used by Modern Electroplating for approximately 40 years. The property was shut down in 1994. The company was sued by EPA, Mass DEP, and BRA because of its poor hazardous material management in 1994.
Current usage:	The property has been abandoned since 1994. Currently the property owner is in litigation.
End use:	Has not decided yet: food related, pharmacy, a parking lot. "…end use should be supported by the community, City of Boston as well." - Attorney General's Office.
Site record:	RTN 3-11352 Massachusetts DEP
Contaminants:	Variety of heavy metals and organic compounds.
Assessment:	Assessment data is available at DEP. Sub-surface and ground water assessment has done by DEP.
Selected remedial alternative:	EPA conducted initial remedial action: removed material stored at the site. Stakeholders are waiting for funding resources to conduct actual site remediation.

Comparison to Lecture-Discussion Only Class

The desired outcome of the introducing CSL activities into the site remediation course was to add value to the educational experience for the students. This added value was derived from the stronger inclusion of soft constraints into the design process. The goal of introducing CSL activities to the course was to minimize its influence on the lecture component while enhancing the design component. Except for a lecture on service learning, no significant changes in lecture material or topics occurred. Given the course's role in ABET-accredited degree programs, engineering design objectives could not and were not changed. The major difference in the course objective was for students to recognize the importance of non-technical constraints on technical design. This distinction is very important if engineers are to develop into more well-rounded, global thinkers and leaders; a criteria of ABET 2000.

With respect to course administration, the only significant change was the addition of a teaching assistant (TA) whose primary duties were to aid the students and the instructor with the project. The TA also enhanced overall course management.

Student Experiences and Reflection

In general, the students enjoyed the service learning activities in the courses. In fact, some students were inspired to try to continue to work on these projects once the course had ended. However, from the discussion session with students, two conclusions are made:

1) Several students did not fully appreciate service learning as valuable pedagogy and was approaching the project as community outreach.
2) The feeling of helping, of truly providing a service is highly desired by the students.

The first conclusion suggests clearly that more could be done in orientation and throughout the course to orient students to the learning process as it involves service learning and fully appreciate service learning as an effective pedagogy. For example, Tufts students are extremely active planning and executing on and off campus activities. However, these activities are not normally tied to the classroom, they are mostly done as the student makes time for them. The hope is to provide a structure for these activities that will benefit the students academic learning and progress.

The second conclusion is gratifying, from an educators point-of-view, as students are often led to accept liberal education as learning for the sake of learning. This conclusion suggests that many students desire learning for the sake of serving. Hence it is our job to help them appreciate serving for the sake of learning. To make this happen, the students gave the following suggestion:

1. Provide more help and guidance on managing the project and on communicating across professions
2. Have more reflection discussions with course professor, SL faculty, SLTA, community partners, etc.
3. Have a firm relationship with community partners to facilitate communications
4. Provide format/structure of record to pass project on to other class to continue the work.

CSL Project Developers and Administrators Experiences and Reflection

As CSL project developers, the authors found the value of CSL activities as clearly positive. As expected, the students were enlightened by the inclusion of service learning into the educational process. More importantly, this service learning experience has refocused our efforts to more fully integrate service learning into more of the curriculum. We see a clear parallel in the service learning process (see Figure 1) and the design process. To realize the maximum benefit of service learning to students and the community, the community partnerships need to be maintained and extended across the curriculum. In summary, the positive impacts of the service learning activities confirmed our desire to continue to do the course with an expanded CSL role that will deepen the students learning and enhance the design experience.

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