Environmental Engineering Education and Community Service: A Synergistic Partnership

Christopher W. Swan, Paul Kirshen, John Durant
Tufts University

Abstract

Community-based service learning, the pedagogy of combining education with community service, exists and has value in a number of academic fields. In the past few years, environmental engineering has become a field where community service learning has been found to be synergistic, providing benefits to both the community and academia. This paper highlights ways in which community service learning can become integrated in an environmental engineering curriculum, how service learning can be a valuable tool in educating tomorrow's engineers, and how service learning can be beneficial to the communities and the academic institution(s) involved.

The experiences of Tufts University are used as specific examples of how community service learning has enriched the traditional environmental engineering curriculum. Whether applied in courses, in student-driven or university-funded initiatives, or in independent projects, community service learning has benefited students, the instructors, and participating communities. As a result, community service learning projects carry more meaning and encouraged greater learning because they involve a real problem. Additionally, the experience extends student learning beyond the technical aspects of the problem to see what impacts environmental issues have on people with a variety of interests and professional backgrounds.

Introduction

A component of the mission statement of Tufts University is “to offer to …students a rigorous education …that provides the knowledge and intellectual skills to become responsible and productive participants and leaders of society; … to enhance learning and develop the potential of each student beyond, as well as within, the classroom; to encourage public service by students, faculty and staff, and to integrate service activities and experiential learning with teaching and research…” In order to implement this broad mission, the engineering curriculum must address both "hard" and "soft" aspects of environmental problems.

Hard aspects concern the broad range of technical expertise needed to be an effective environmental engineer. Hard aspects in environmental problems come from a variety of technical disciplines including engineering (civil, mechanical, chemical, etc.), natural sciences (geology, chemistry, physics, biology, etc.) and specialized disciplines (microbiology, geochemistry, toxicology, etc.). However, effectively developing solutions to environmental problems often involves expertise in addressing non-technical, or soft, aspects. These aspects involve project management, communication, local and regional politics, economics, and social concerns of affected stakeholders.

In most engineering design courses, these soft aspects typically are ignored. However, with respect to a number of environmental problems, soft aspects are just as, if not more, important to the overall success of the chosen environmental design. For the past few years, the department of Civil and Environmental Engineering at Tufts University has used components of community-based service learning to enhance the learning experience of students in its environmental engineering curriculum. This paper describes the pedagogical process used in teaching environmental engineering and highlights some of the ways community-based service learning, the pedagogy of combining education with community service, is used in environmental engineering education at Tufts University.

Pedagogical Process

Traditional Pedagogical Process

Just as there are both hard and soft aspects to environmental engineering problems, both hard and soft constraints exist in developing solutions. For example, in the remediation of contaminated sites, limited physical and chemical information for soil, water, and groundwater represent hard constraints. Soft constraints to the design include evaluating and reconciling the viewpoints of the various community stakeholders. However, in traditional environmental engineering education, the soft constraints are often ignored or not emphasized. This is partly due to the strong technical expertise needed to solve environmental problem solving. It is also due to the desire to specifically satisfy the technical requirements established by the Accreditation Board for Engineering and Technology (ABET); namely points a and c of Criterion 3 Program Outcomes and Assessment of ABET's Criteria for Accrediting Engineering Programs. In a typical course, the pedagogical process, as illustrated in Figure 1, would be linear with the emphasis on technical evaluation. Curriculum based on this process would involve homework assignments, exams, and a final project; all emphasizing analysis and evaluation of collected data followed by design calculations.

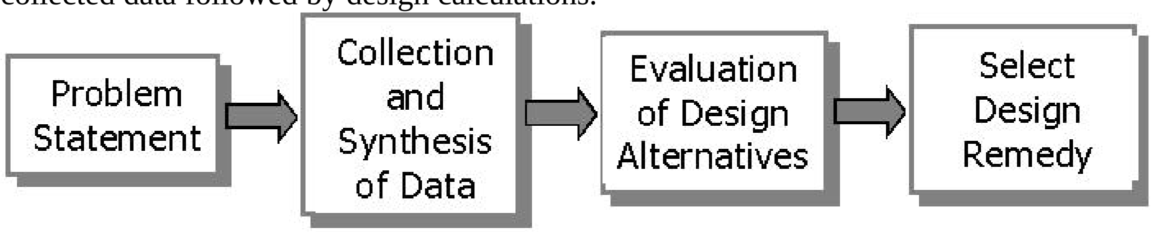

Figure 1 Traditional Pedagogy in an Engineering Design Course

New Pedagogical Emphasis

However, Criterion 3 also cites the need for engineering students to communicate effectively (point g) and understand the impact of engineering solutions in a global and societal context (point h). Community-based service learning is a pedagogical tool that has helped students develop this deeper appreciation of engineering as well as to communicate their engineering solutions to both a technical and lay audience. The new pedagogical process forces students to consider both hard and soft constraints in environmental engineering design, yet it allows the curriculum to remain true to ABET criteria for technical design. As shown in Figure 2, this methodology is more iterative, making the learning process dynamic and evolving. This process forces the students to “dive deeper” into the problem so as to understand it better.

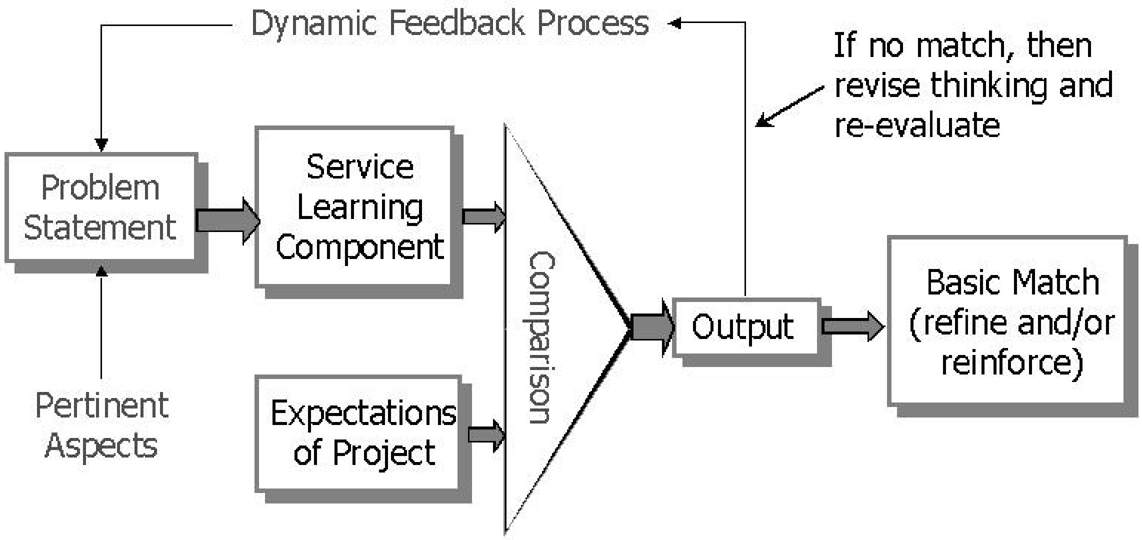

Figure 2 Schematic of Service Learning Pedagogy

Examples of Service Learning in Environmental Engineering Curriculum

Example Environmental Engineering Course - Environmental Site Remediation

In the past, the site remediation course at Tufts University consisted of homework assignments, mid-term and final exams, and a design project; following the linear pedagogical model shown in Figure 1. The design project, an open-ended problem that requires students to design a remediation scheme for a contaminated site, constituted 40% of the course grade and required a mostly technical evaluation of the remediation of a fictitious site. Recently, Swan et al (1999) described the incorporation of community-based service learning (CSL) into the design project. Each project required the development of appropriate remedial strategies for small, urban brownfield sites in metropolitan Boston, MA that were undergoing or needed to undergo remediation. These projects enhanced the students' learning in two ways. First, the students were forced to address both technical and non-technical constraints in their remediation designs. Second, the students would need to interact with the actual stakeholders (community, developers, regulators, etc.) involved in the re-development of abandoned, yet desirable, real estate. In essence, the students could now act as "technical liaisons" to the lay community in the remediation process. The following describes the assessment tools that were used to measure the effectiveness of CSL projects and a summary of one of these projects.

Assessment tools for the projects included a group journal, status reports, oral presentations and a final report. The group journals provided a weekly documentation of group activities during the project. Two status reports were developed detailing what each group had done and what they will be doing with regard to the project. Each group also had to provide two oral presentations and a final report detailing the design and analysis of the remediation strategies that were evaluated. If possible, the group members would interact with the various stakeholders who wished to participate in the project.

An example project was the Hawthorne Site in Roxbury (Boston), MA. This 2.45 acres site had been used by a variety of consumer good manufacturers from the late 1800’s to the mid-1970’s. Abandoned in the 1980’s, the site became a prime location for illegal or “midnight” dumping. Environmental investigations found a number of contaminants of concern including a variety of carcinogenic compounds (polycyclic aromatic hydrocarbons) in both soil and groundwater samples. Stakeholders involved with the site include a community group and their legal support; the owner and potential developer; an engineering consultant; and Massachusetts Department of Environmental Protection. The major conflict: potential end use. The community would like to see a few homes with a significant portion of these homes being affordable. The owner would like to have more homes with a lower percentage of them classified as affordable houses.

The major end product of the project was a design report of how to better develop the site for residential use with additional remedial measures. However, during the project, the students found themselves acting as technical liaisons and advocates for community. They reviewed the developer's plans, provided criticism to proposed remediation and development scheme, and developed alternative remediation designs that would enhance the health and welfare of the future residents. The presentation of the group's findings and work lead the developer to re-evaluate his proposed plan!

Mystic Watershed Collaborative

The Mystic Watershed Collaborative (MWC) is a long-term partnership between the Tufts University Water Sustainability, Health, and Ecological Diversity (WaterSHED) Center, the Tufts Institute of the Environment, the Tufts University College of Citizenship and Public Service and the Mystic River Watershed Association (MyRWA). The goals of the MWC are to contribute to 1) restoring of watershed ecosystems, 2) improving water quality and flood management, 3) providing public access to the river, 4) increasing public awareness of watershed problems, and 5) encouraging new forms of governance that will be more effective than the current fragmentation of responsibility among state agencies and local municipalities.

Background

The Mystic River is in an urban watershed with headwaters northwest of Boston, MA and flowing into Boston Harbor. It covers approximately 70 square miles in 21 municipalities, and is home to approximately 400,000 people of numerous ethnic backgrounds and socioeconomic levels. Although the Mystic has been neglected in the recent wave of national attention to watershed management, the book and movie <u>A Civil Action</u> was based on the leaching of toxic chemicals from old waste disposal sites in the upper Mystic watershed. Other water resource and watershed management problems in the watershed include 1) discharge of untreated sewage to surface waters during storms, 2) increasingly severe flooding, 3) contamination of sediments, and 4) lack of public access to---or even public awareness of---the river, especially in the lower reaches of the watershed.

Development of MWC

Tufts' involvement is lead by the WaterSHED Center, formed as an inter-disciplinary center of the Department of Civil and Environmental Engineering and the School of Medicine and sponsored by the Tufts Institute of the Environment (TIE). The WaterSHED center brings together faculty for research, outreach and educational projects from academic departments within the School of Arts and Sciences; the School of Engineering, the School of Medicine; the School of Veterinary Medicine; and the School of Nutrition Sciences and Policy. An initial focus of the center has been activities in local and overseas watersheds where Tufts University has campuses. The main campus of Tufts (Medford/Somerville, MA) is located in the southern part of the Mystic River watershed. The other important Tufts entity is the University College of

Citizenship and Public Service (UCCPS), which serves as an internal college "without walls" to foster citizenship and public service through education, research, training, and service.

The Mystic River Watershed Association, (MyRWA) is the community partner organization in the MWC. The MyRWA is a non-governmental organization representing citizens, business and development groups, grassroots organizations, recreational associations, federal and state environmental agencies, state legislature, and municipal governments with an interest in the watershed. It advocates for the river at the state and local level, sponsors riverbank cleanups and tours, and promotes better awareness of watershed problems among residents. The MyRWA has the goal of making the river fishable and swimmable by 2020.

MWC Function and Role in Environmental Engineering Education and Outreach

The MWC allows Tufts University to undertake activities that support meeting the watershed priorities identified by the community and coordinated by the MyRWA. In order to remain an effective source of factual information, Tufts and the MWC do not undertake any advocacy activities in the basin. However, MWC activities are public and are available for use by any organization including the MyRWA.

Tufts University faculty, staff and students have carried out research, educational, public service, and outreach activities in the Mystic River Watershed for many years and the MWC builds upon these activities. Examples of some of the past and current activities of the MWC are several workshops on the basin, numerous coordination meetings, and service learning classes at Tufts. The third River Institute, an interdisciplinary summer school class on river restoration theory and practice focused on the Mystic Watershed, is scheduled for the Summer 2002.

Students have also benefited from the work of the collaborative. Student-volunteer efforts in water quality sampling of the Mystic River has lead to the use of sampling results in engineering courses on water quality modeling. In addition, the research activities of the WaterSHED center have been strengthened by its participation in the MWC. For example, a grant was recently awarded to the City of Somerville, the MyRWA, and Tufts to install a real-time water quality network in the basin for citizen outreach and scientific data collection.

Conclusions

The synergistic effects of combining environmental engineering with CSL are evident in the enhanced education received by both students and faculty and the new spirit of collaboration developed between participating communities and the university. For example, in the site remediation course at Tufts, and other courses that incorporate CSL components, a number of benefits to student learning are evident.

1. Traditional design pedagogy plus CSL provided students complimentary vehicles in which to refine their designs in ways that deepened their understanding and learning.
2. The added value of CSL in the curriculum forces students to recognize that all aspects of design (hard and soft) are important.
3. Use of CSL oriented projects causes students to "think outside the technical box" to develop appropriate and realistic environmental designs.
4. Students come to realize that professional and social responsibilities go together.

In general students find that their course work has more meaning, and they become more engaged to accomplish greater learning because the course involves actual environmental problems. The feeling of helping, of truly providing a service to an affected community is highly desired by the students and provides an additional motivation to learning. This suggests that many students desire a liberal education that not only emphasizes learning for the sake of learning but also for the sake of serving.

From the perspective of the course or program administrators, CSL inclusion is a successful way to have students recognize the importance of soft constraints on technical design. This is important since engineers should develop into more well-rounded, global thinkers and leaders - a ABET 2000 criteria. As illustrated in Figure 2, the goal of CSL should be to create students who will continually revise and refine their perspectives on engineering design. Thus creating students who not only value life-long learning, but practice it.

From a community's perspective, community-based service learning provides a tangible benefit in that an environmental problem is being evaluated. In addition, the community can now look to the university to partner in evaluating and solving environmental and other problems.

One pedagogical downside is that in some cases students approached their projects as community outreach, and; therefore, did not recognize service learning as valuable pedagogy. In other words, looking at the project as a community service "event" would not necessarily lead to a life-long desire for learning through active citizenship. Therefore, caution should be taken not to create only "projects" or to assign service learning to one course. To truly implement CSL in an academic setting requires the establishment of collaborative relationships with community partners with the service bridging across the various academic disciplines of the university. This implementation and partnership(s) must be maintained continuously.

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CHRISTOPHER W. SWAN
Dr. Swan is an Associate Professor in the Civil and Environmental Engineering department at Tufts University. His current interests are the reuse of recovered or recyclable materials and environmental site remediation.

PAUL KIRSHEN
Dr. Kirshen is a Research Associate Professor in the Civil and Environmental Engineering department and in Fletcher School of Law and Diplomacy at Tufts University. He also serves as the director of WaterSHED Center. His current research is in the areas of climate change and watershed systems.

JOHN DURANT
Dr. Durant is an Associate Professor in the Civil and Environmental Engineering department at Tufts University. His current interest is the fate and transport of contaminants in the environment.