Civil Engineering Service Learning Projects: Local and Global Perspectives

William J. Davis and Thomas R. Dion[1]

Abstract – Ethical cannons of the engineering profession require civil engineering graduates be principled leaders through the crucial role they will play in planning, design, and construction of the built-environment needed to establish safe, healthy, equitable and vibrant communities. These ideals are reflected in a national academic movement to include "service learning" as a crucial educational component of the undergraduate curriculum. The Citadel's service learning initiatives in civil engineering are aimed at engaging students to participate in data collection and analysis of local infrastructure projects. These experiential learning projects are commonly performed on behalf of local government and have been effective in providing meaningful and lasting contributions to the local community, forging enhanced partnerships between the college and community, and creating valuable lessons in educating tomorrows' leaders through hands-on experience on how to institute change. Through participation in these opportunities, students gain first-hand knowledge of engineering practice, actively contribute to their community through the service they perform, and develop a personal appreciation for civic responsibility.

Keywords: Service Learning, Experiential Learning, Community Service Projects,

INTRODUCTION

The professional practice of civil engineering is focused on meeting the needs of communities and providing service to society. Engineering and design services provided by civil engineers are civic-centered with overarching objectives of ensuring the health, welfare, and well being of communities. In an effort to engage more people to improve civic service and quality of life in communities, President George H. W. Bush signed into law the National and Community Service Act of 1990. [1] [2] This legislation encouraged renewal in performing community service and volunteerism by targeting K-12 school-aged children, as well as higher education. Three years later the Corporation for National and Community Service was established to include Senior Corps, AmeriCorps, and Learn and Serve America. As a result, the Corporation represents a public commitment to fostering good citizenship through fostering volunteer service focused on meaningful and socially responsible initiatives. These national service efforts directly coincide with guiding principles of the civil engineering profession whose mission is to provide safe, healthy, equitable and vibrant communities through well-designed public infrastructure and built environments.

One of the ideas that evolved from this national policy initiative focused on the value and potential of adopting an educational approach for "service learning". According to the National Service Learning Clearing House, service learning is **"**a teaching and learning strategy integrating meaningful community service with academic instruction and reflection to enrich the learning experience, teach civic responsibility, and strengthen communities." [3] These ideals are reflected in a national academic movement to include "service learning" as a crucial academic component of the undergraduate curriculum in higher education. From a

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civil engineering educational perspective, these learning strategies require that students apply their understanding of classroom material to help solve real-world engineering problems whether within the US or communities around the globe.

Defining Service Learning

Service learning can be defined in a variety of terms and administered in a wide array of educational contexts. A central approach seeks to engage student learning and enrichment while actively participating in applying knowledge to solve real world problems, rather than through the setting of traditionally esoteric direct instruction in classroom setting. This 'experiential' learning approach, places a premium on immersing students in a challenging and engaging individual learning process, driven by the desire to serve others through their self-initiated, meaningful contributions. An example of this contrast in learning settings and potential for enrichment would be a student who visits a hydraulics laboratory to observe various scientific flow parameters, rather than learning through working with a team to help resolve community flooding or water resource issues. As a result of the latter, students are inspired to apply knowledge for the benefit of others to improve their quality of life and meet the needs of a community. Because discovery and knowledge is inspired through first hand experiences, students develop and adopt an internal desire to actively engage in learning, application and reflection. Student learners first must have enough foundational knowledge and problem solving skills to be adequately prepared to be engaged in a meaningful context of understanding issues, technical procedures and feasible solutions necessary to participate in development and application of new ideas. Although the role of academic direct lecturing provides students with a needed avenue of imparting knowledge that may or may not be effectively retained, personal engagement using an experiential learning approach can be used to help students become inspired to understand and create effective solutions when afforded an opportunity to help meet the needs of others.

A central theme in service learning is to provide students with "community service experiences to enrich and expand academic scholarship" according to Martin and Hague [4]. This approach provides benefits to the community while enabling students to apply their knowledge and skills within a real world setting. Because community service projects can closely relate to the practice of civil engineering, many undergraduate programs are beginning to include these type activities and projects as part of their undergraduate student experience through a variety of experiences and applications. Thirty years ago community service projects may have been incorporated into an individual student's project or as part of a professional organization's service activity. Today service learning appears to be maturing as a means of addressing a range of societal needs, and as a result, community based service learning projects are being incorporated into countless academic courses, educational programs and institutional curriculums.

Service Learning Projects and Opportunities

Service learning opportunities have taken a variety of forms over the years at The Citadel. The most common projects have included team efforts conducted through the ASCE student chapter, individual student participation engineering projects abroad, and volunteer projects that focused on meeting a need in the community. All projects have been conducted on behalf of a government agency/jurisdiction or through affiliation with a non-profit organization. Examples of recent team and individual service learning projects conducted by civil engineering students at The Citadel are summarized in Table 1.

Year	Project Title	Participants	Number of Students
2011	Battery to Beach	Citadel ASCE Chapter	25
2011	Ring Memorial Elevation Study	Citadel ASCE Chapter	22
2010	Patriot's Point Traffic Study	Citadel ASCE Chapter	15
2010	Engineers Without Borders-Duke Univ. Student Team-Water Project Bolivia	Cadet Jordan Panter joined team as additional member	1 from Citadel, plus other students
2010	Water Missions International—Water Project Kenya	Cadet Ben Mims joined team as additional member	1 from Citadel, plus other students
2009	Isle of Palms Marina Parking Study	Citadel ASCE Chapter	30
2009	Engineers Without Borders-Clemson Univ. Student Team—Water Project El Salvador	Cadet Ryan Keiper joined team as an additional member	1 from Citadel, plus other students
2008-2009	Capers Hall/Bicentennial Monument Survey	Citadel ASCE Chapter	4
2007-2008	Citadel Yacht Club Survey	Citadel ASCE Chapter	35
2005-2006	Carolina Avenue Traffic Study—Town of Summerville, SC	Citadel ASCE Chapter	30
2003-2004	South Main Street Survey—Town of Summerville, SC	Citadel ASCE Chapter	15
2000	Jerry Backwell Playground Construction—Town of Summerville, SC	Citadel ASCE Chapter	24
1998	Bonneau Ferry Ricefield Survey	Citadel ASCE Chapter	12
1996-1998	Detmold Resurvey—Town of Summerville	Citadel ASCE Chapter	50
1996	Peace Corps—Nepal Water Project	Cadet Rich Rotto joined as a team member	1 from Citadel, plus other students

Table 1. Representative student service learning projects undertaken by The Citadel during previous 15 years.

A summary of each of these student service learning projects is provided as follows:

2011, Battery to Beach Bicycle and Pedestrian Path Planning Study - Students conducted a transportation planning project on a 33-mile pedestrian and bicycle path in Charleston extending through five municipalities. The project involved collecting extensive route data, analysis, construction cost estimating and public presentations to local officials. 25 students participating in the project have spent over 1,500 hours working on data collection, data processing and engineering analysis tasks. In addition, students presented their findings in a number of public forums to decision makers and local politicians.

2011, Ring Memorial Elevation Study. Students conducted field and office work to determine elevations of various markers that were to be used to set up a ring memorial on the parade ground. Approximately 22 ASCE Student Chapter members were involved in this project

2010, Patriots Point Naval Museum Traffic and Parking Study – This project involved 15 students working to evaluating parking and traffic circulation issues at Patriots Point Naval & Maritime Museum home of the USS Yorktown. Students collected data to evaluate parking occupancy, develop preliminary parking layouts and analyze traffic flow data from special events. Results will be used by the Director of Operations to evaluate possible transportation improvements.

2010, Engineers Without Borders—Duke University Student Sponsored Team, Water Project in Bolivia. Cadet Jordan Panter from The Citadel joined as an additional team member to work on this project.

2010, Water Missions International—Water Project in Kenya Africa. Cadet Ben Mims joined as a member of a team that worked on several water projects during the Summer of 2010. A lot of his surveying and hydraulic engineering knowledge was put to use while there.

2009, Isle of Palms Marina Parking and Circulation Plan – Students conducted an traffic engineering study at the Isle of Palms Marina involving license plate matching, vehicle classification counts, 24-hour ADT counts, customer surveys, and business interviews. 30 students participating in the project have spent over 250 hours working on data collection, data processing and engineering analysis tasks. Students presented their findings to the mayor and town council during a public meeting.

2009, Engineers Without Borders—Clemson University Student Sponsored Team, Water Project in El Salvador. Cadet Ryan Keiper joined as an additional team member to work on this project. Ryan ran most of the surveying operations to help determine elevation differences for hydraulic analysis.

2008-2009, Citadel Campus Capers Hall/Bicentennial Memorial Master Planning Survey Project. Students conducted field work and then downloaded data to create final survey drawing under the supervision of a faculty member who is a registered land surveyor. This survey was then used to help plan for a Memorial to help celebrate the 200th Birthday of The Citadel in 2042. Four students were involved with this project.

2007-2008, Citadel Campus Yacht Club Survey Project – Students conducted field work and then downloaded and created a final topographic map under the supervision of a faculty member who is a registered land surveyor. This survey was used by the institution to help update their Master Plan and provide ideas to improve the existing yacht club area. Approximately 35 students worked on this project.

2005-2006, Carolina Avenue Transportation Corridor Study - Students collected data, conducted analysis, prepared final report and presented findings of W. Carolina Avenue Traffic Study in Summerville involving 30 student volunteers who conducted traffic data collection, evaluated site conditions, analyzed traffic flow and prepared submittal materials for the town engineer. In addition, students presented their findings to the mayor and town council during a public meeting on 13 September 2006.

2003-2004, South Main Street Survey—Town of Summerville, SC. – Students collected field data and then downloaded to produce a map of a section of Main Street that was used by the State Department of Transportation to reduce the number of lanes from two in each direction down to one in each direction so as to allow traffic calming and additional parking downtown. Fifteen ASCE Student Chapter members worked on this project, and the finished project has been well received by the public.

2000, Jerry Blackwell Playground Construction—Town of Summerville, SC – Two dozen ASCE Student Chapter members put in a full 8 hour day on 30 September 2000 when they helped construct a new playground owned by the Town of Summerville. There were approximately 100 additional persons working along with the Cadets. Since it was built, this playground has provided a welcome outlet for local children, and is also much enjoyed by parents too.

1998, Bonneau Ferry Ricefield Survey in Berkeley County, SC. Twelve ASCE Student Chapter members conducted a GPS and later conventional survey of a tidal rice field for use in an ongoing research project. Dr. Joe Kelley and Richard Porcher needed this survey data to try to correlate vegetation to water depths in the impoundment. This area is brackish water that is subject to tidal action, thus requiring an accurate determination of all elevations.

1996-1998, Summerville Detmold Surveying Control Project - The Town of Summerville was created in the middle 1800's, with its street map never being staked on the ground. Over the years Town Council had over 200 property line disputes because no one knew where the map's origin was located on the ground. As a result, the ASCE Student Chapter undertook a GPS and conventional survey of the major control points found in town, and did a readjustment of all control to best fit the intention of the original street layout. As a result of this effort, Town Council has had no property line related issues since this project was completed. Approximately 50 students as various times worked on this project.

1996, Peace Corps—Nepal Water Projects. Cadet Rich Rotto volunteered to work on several water related projects in Nepal during 1996, where he was able to apply his learned knowledge in assisting local people in securing safe supplies of water.

Each of these projects, whether locally or globally located, provided opportunities for students to apply learned knowledge in solving real world problems. Although site specific details differ locally and globally, the experiences gained through student service learning provide similar benefits; therefore, just because an institution has limited opportunities for global involvement, that does not mean that similar benefits cannot be obtained locally.

Current Service Learning Trends

Currently student service learning opportunities are more widely available and range in scope than ever possible in the past. This is due in large part with the every increasing need of local communities and volunteer enthusiasm to work collectively and collaboratively to meet these needs. Lack of public funds or lack of qualified personnel often drives communities to inquire about receiving technical help from students and student

organizations. Faculty members frequently provide the technical expertise necessary to deal with the community when considering making a commitment to a particular project, as well as be in a position to advise, organize and schedule student involvement for project commitments. By working through a student professional organization, such as ASCE Student Chapter, or in conjunction with various scheduled courses, students' participation can be structured to provide meaningful learning experiences while constituting beneficial service to the community.

Trends in higher education are towards incorporating more student service learning activities into college programs and formally institutionalizing offerings into the undergraduate curricula. For example, The Citadel has recently created a sophomore leadership course that includes an eight-hour service learning component as part of the course requirements. All Cadets, regardless of degree major, must complete this course and participate in service learning activities. Types of service learning include: habitat for humanity projects, literacy assistance, etc.

Other institutions are using the American Society of Civil Engineer's Body Of Knowledge, 2nd Ed. Guidelines [5], for example, as a way to include service learning experiences. Assessment outcomes such as team work, ethics, professionalism, communication, and social impacts help mold how service learning will be implemented from opportunity to opportunity. Various institutions have successfully incorporated service learning into their curricula using a variety of approaches with good results [6][7][8][9][10][11][12][13]. There is agreement that in order for service learning to be successful, it must be planned out in advance. The scope of endeavor must be pretty well defined in order to complete it within the allocated window of time. In addition, assistance provided by the service learning beneficiary can help everyone involved. An example involving a traffic related service learning problem would be the use of town policemen to help with traffic control when data are being collected in the field when studying the town's traffic needs. Not only does this increase the safety of the students, it also helps protect equipment as well as make the public aware that activities relating to civic improvements are underway.

EVALUATION AND ASSESSMENT

From review of data provided in Table 1 it is evident that less than 50 percent of students are being engaged in a service learning activity or project. Student participation in service learning is encouraged, however, occurs on a purely voluntary basis, which limits effective connection to program outcomes assessment. Obviously more steps will need to be taken to fully integrate service learning into the curriculum and civil engineering student development program. A considerable amount of effort has been placed on transiting faculty focus from community service to service learning projects and promoting the benefits for these type student activities. Most projects have occurred in surveying and transportation, which more readily allow students work on projects to assimilate data, compile preliminary results and present findings in a public forum. Faculty are identifying, organizing and promoting service learning projects on their own initiative for the benefit of student learning and to provide service to the community. Collectively, these factors limit the effectiveness of all that service learning initiatives can provide within an undergraduate engineering curriculum. Regardless, current efforts are helping provide a foundation and establish the basis for more formal adoption of service learning principles and instructional implementation within the program and curriculum in the future.

Mapping to ASCE BOK 2

To illustrate the impact on student leaning and how the potential for service learning opportunities is currently being developed, elements of the most recent service learning project, Battery to Beach (B2B) Benefit Cost Study will be discussed in more detail. The project was performed through collaborations with two non-profit organizations, the College of Charleston, city government, and a local high school. Major project tasks included:

1. Collect field data for over 60-miles of primary and alternative routes, including 107 route roadway segments extending through six municipal jurisdictions.
2. Conduct pedestrian and bicycle level of service analysis for each of the 107 route segments.
3. Create ArcGIS database with mapping to include all route data and analysis.
4. Create photo inventory of existing conditions along all route segments.
5. Conduct traffic operations analysis on US17 Ashley River Bridge to determine feasibility of reducing travel lanes to provide a lane for use by pedestrians and bicycles.
6. Develop list of planned and future projects along the proposed route that could be adapted to accommodate B2B route and identify possible route improvements.
7. Develop preliminary cost estimate for all B2B improvements including bike lanes, sidewalks, ADA ramps, crosswalk pavement markings, pedestrian push buttons, signage and other requirements to provide desired facility. ($20 million)
8. Determine list of transportation network improvements needed for all Charleston area roadway users along proposed route and including B2B improvements. ($75 million)
9. Publish, *Battery 2 Beach: Route Evaluation, Engineering Analysis and Construction Cost Estimate, FINAL REPORT*, Nov. 23, 2011.
10. Combine engineering and construction cost findings with project benefits, published in *A Cost Benefit Analysis of the proposed Battery to Beach Multi-Use Path*, Tiffany Renee Norton, Graduate College, College of Charleston, Dec. 5, 2011.
11. Provide six public presentations, including presenting study findings and leading group discussions at a design charrette attendee by 50 politicians, community leaders, engineers, planners and local press.
12. Publicize study findings through various publications and interaction with local media.

As these project activities require a high level of engineering design and application, mapping of these components to American Society of Civil Engineer's Body Of Knowledge, 2nd Edition (ASCE BOK 2) [5] provides an informative indication of the potential for properly structured service learning initiatives to support and foster student learning and development. As shown in Table 2, eleven of twenty-four ASCE BOK 2 outcomes are addressed at Blooms Taxonomy levels ranging from Application (3) to Synthesis (5). Even though voluntary and involving 50 percent of students, this work was very effective in supplementing classroom instruction with this type of rigorous service learning activity. Since the project was frequently discussed in class as the work was being performed, all students gained some knowledge of the work being performed and attained some appreciation for the importance of service learning principles.

ASCE BOK 2 Outcome	Blooms Level	Student service learning activity
9. Design	Synthesis (5)	Design concepts were developed for bike lane widening, sidewalk and multiuse path construction.
10. Sustainability	Application (3)	Collaborated with College of Charleston environmental studies grad student to assess benefits of non-motorized urban travel modes.
11. Contemporary Issues	Analysis (4)	Tracked articles, letters to editor, and editorials in local media related to pedestrian and bicycle safety and facility needs for the Charleston area.
16. Communication	Synthesis (5)	Provide six presentations to decision makers, and project stakeholders in public forums.
17. Public Policy	Analysis (4)	Assimilated national design standards and analytical methods for use in project development and interacted with local officials to explain basis of their work.
18. Public Administration	Analysis (4)	Addressed right-of-way, utility, environmental, operational and maintenance issues in manner that was acceptable to local jurisdictions.
20. Leadership	Analysis (4)	Interacted with a variety of stakeholders to inform, educate, and inspire advancement of B2B project concepts and implementation.
21. Teamwork	Analysis (4)	Five leaders, seven presenters and 25 student workers conducted project tasks collaboratively over 1.5 year schedule to B-C Study completion.
22. Attitudes	Application (3)	Students worked to understand and address issues of members of the public and transportation users who embodied drastically different values.
23. Lifelong Learning	Application (3)	Students researched methods and conducted analysis, GIS mapping and other task that were new to them
24. Professional Responsibility	Application (3)	Student efforts embodied principles of professional responsibility by conducting this work for the community

Table 2. Mapping of ASCE BOK 2 Program Outcomes and Blooms Taxonomy to Battery to Beach Service student service learning project activities.

Needed Improvements and Curriculum Issues

As service learning projects are further integrated into the civil engineering student development program, more formalize means of evaluation and assessment need to be adopted, including student reflection. Additionally, steps should be taken to engage a larger number of students to participate in these meaningful learning initiatives. Modifying the curriculum to incorporate service learning into the program would provide needed connection to program outcomes through inclusion of all students. A major impediment in taking this step resides in the fact that the civil engineering program requires the highest number of credit hour totals for all fifteen undergraduate degrees offered at The Citadel. Therefore it is not an option to simply add another required course. Modifying the curriculum would mean removing a class that is currently required and mapped to program outcomes. The Citadel requires all undergraduates complete a core curriculum consisting of twenty-four credit hours in English, history and humanities. With such an emphasis on non technical courses, in addition to required ROTC courses of a military college, options to modify the curriculum center on courses provided within the civil engineering department.

Eliminating long-standing engineering courses and course content is a difficult to attain consensus. Furthermore many of these traditionally based courses are crucial in preparing students to pass the fundamental of engineering examination. With an emphasis on preparing graduates for professional practice through licensure, it will be difficult to implement changes in the curriculum that dedicate time to student learning objective that are perceived to be less technical. Nevertheless, evidence-based reasons to further incorporate student service learning into the curriculum will continue. During the interim, the approach currently being used in civil engineering at The Citadel is accomplishing many of the goals of service learning. This supposition has received some reinforcement through The Citadel's Student Chapter of ASCE receiving both the 2010 and 2011 ASCE Richard J. Scranton National Outstanding Community Service Award in recognition of exceptional service by civil engineering students.

SUMMARY AND CONCLUSIONS

Numerous beneficial educational outcomes are achieved through student service learning projects [14][15], even though more formalized tracking, improved assessment methods, and means to incorporate student reflection are still being further development. First, and foremost, student service learning provides enriching academic learning opportunities not attainable within a classroom setting. Secondly, projects provide students intrinsic motivation to strive for excellence in applying their knowledge in their field of study and technical skills attained since others are depending upon and will be affected through the results of their efforts and hard work. Additional benefits include departmental recognition as well as providing academic institutions with opportunities for positive contributions to the communities in which they reside. Furthermore, some overarching goals and global educational outcomes adopted by most colleges and universities may be difficult to accomplish unless student service learning are embraced and implemented as part of a comprehensive student academic development and scholarly learning program. Finally, service learning projects can provide an excellent and meaningful forum for students to receive positive feedback from the community regarding the importance of their technical skills and chosen profession to the wellbeing of neighborhoods, communities, and our broader society.

Students, faculty and administrators at The Citadel are working collaboratively to rise to the challenge of the high calling of being an engineer by embracing ethical cannons of the engineering profession that require civil engineering graduates be principled leaders. Student leadership skills obtained through service learning are a highly effective means of preparing future engineers to serve a crucial role in planning, design, and construction of a built-environment needed to establish safe, healthy, equitable and vibrant communities.

Ideals of student responsibility to rigorously prepare for professional practice are being dramatically influenced through enthusiastic participation in meaningful student service learning projects that challenge students to apply their knowledge to help address real-world engineering problems. Through involvement in service learning projects, civil engineering students at The Citadel are gaining first-hand knowledge of engineering practice, actively contributing to their community through the service they perform, and developing a personal appreciation for civic pride and personal responsibility. Participation in these service learning activities have enhanced the program's learning environment by empowering students to apply skills and knowledge obtained within classroom settings. The results often produce a tangible benefit to the community, and foster enriching intangible societal development of student participants that can have long-term transformative impacts.

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