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Engagement in Practice: A Case Study in Construction Engineering Practicum Course at University "X"

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Introduction

Successful Construction Engineering programs engage students in meaningful projects that motivate them to exceed minimum expectations. Undergraduate capstone projects, often involving real clients, site visits, and milestone briefings, prepare students for professional roles. However, students sometimes overlook the community impact of their work. Beyond estimates, schedules, analyses, and design, hands-on construction experience is essential. While internships are a primary vehicle for developing these skills, some students face scheduling challenges. To address this, the Construction Engineering Program at The Citadel partners with Habitat for Humanity to offer a practicum that provides hands-on construction experience while fostering a sense of service to the greater community. Many students are inspired to return on weekends, volunteering with their fraternity and building alongside future homeowners.

Background

Service-learning is a teaching strategy that integrates meaningful community service with instruction and reflection, enriching the learning experience, teaching civic responsibility, and strengthening communities [1-2]. Unlike volunteering, service learning includes a curriculum, and unlike internships, it is designed to address specific community needs [1]. By combining formal instruction with community service, it offers a practical and progressive learning experience [2]. The principles of service learning align with the theories and research of educators and developmental psychologists such as Dewey, Piaget, Kolb, Kohlberg, Perry, Belenky et al., Baxter Magolda, and Coles [3-4]. Kolb's experiential learning model is particularly relevant, emphasizing the role of experience through the dimensions of feeling, reflecting, thinking, and doing [5-8].

This paper presents a case study on developing and sustaining partnerships, managing weather-dependent construction schedules, evaluating students, and lessons learned from successes and challenges in an undergraduate Construction Engineering Practicum course.

Service-Learning Design and Execution in Practicum Course

In Construction Engineering, employers often expect not only the design and analysis skills of students but also knowledge of hands-on construction techniques and methods. The Construction Engineering program at The Citadel provides hands-on experience through a two-semester capstone project parallel to the Civil Engineering Capstone course and a practicum where students apply construction methods to build a housing structure using appropriate materials. The practicum addresses the challenge of students unable to secure internships for hands-on experience before graduation.

The Construction Engineering program was designed specifically for students pursuing construction careers, setting it apart from the more design-focused Civil Engineering curriculum. Many students at The Citadel lacked internship opportunities (e.g., military contract students, athletes, or those facing academic challenges), prompting the program to include a final-semester practicum to ensure graduates gained essential hands-on field experience.

Finding organizations to support such practicums can be challenging. Many companies and firms hesitate to involve students in construction projects due to liability, union rules, or project complexity (e.g., high-elevation steel construction). To address these barriers, The Citadel leverages its strong service-oriented culture. Each fall, the university hosts a Leadership Day, where freshmen and sophomores participate in service projects like Habitat for Humanity, with sophomores leading freshmen groups. Fraternities (cadet companies) also conduct service projects, contributing to the institution's Carnegie Service classification. Building on this foundation, the practicum incorporates Habitat for Humanity projects during the spring of students' senior year, offering meaningful hands-on construction experience.

Developing the practicum presented challenges. Many students lacked skills, making it difficult to secure partnerships with construction companies willing to allow learning through mistakes. However, a faculty member's volunteer work with Habitat for Humanity led to a partnership with a nearby office just two miles away. As part of the arrangement, students worked at Habitat sites every Wednesday afternoon (1-5 PM) for 13 weeks, with Saturdays dedicated to engaging with future homeowners. To enhance learning, the course instructor, with approval from the Director of Construction, rotated students across various Habitat programs and sites. This approach ensured exposure to diverse, hands-on construction experiences while meeting course objectives.

Weekly assignments provide students with experience in construction site reporting and offer documents for assessing ABET student outcomes such as leadership, sustainability, risk management, and engineering economics. Assignments include a Field Report, "How-To Guide," and Leadership Assessment.

The Field Report mirrors a typical daily construction report, covering key details (who, what, where, when; progress; disputes, change orders, delays; quality assurance/control concerns). It also incorporates ABET- specific elements like risk and uncertainty with recommendations, sustainability practices, and economic issues. Over the semester, the 12-13 weekly reports are compiled into a final, comprehensive Field Report (.i.e., mirroring the monthly Field Report). Quick feedback on submissions allows students to refine their critical thinking and improve their weekly reporting practices, ensuring continuous development.

Each week, students engage in a unique construction experience, culminating in a section of a “How-To Guide” documenting materials, methods, tools, and safety protocols. The guide is intended as an initial training resource for future Habitat for Humanity volunteers. Each section outlines required materials and tools, safety considerations, and step-by-step construction procedures, supplemented with key pictures. This assignment develops students’ ability to create training materials for future employees. Quick feedback on submissions helps students critically evaluate and improve their work, refining their approach to future sections.

Team and leadership development, essential for ABET Student Outcome 5, are particularly critical on construction sites. Each student rotates weekly as a team leader of a 3-4 person group, completing construction tasks. At the end of each day, students assess themselves and their teammates (Table 1). Teams are reshuffled every 3-4 weeks to ensure students work with a variety of peers in both roles, mirroring the dynamic nature of working with different subcontractors onsite.

Table 1. Leadership Assessment Model adapted from [9].

1	**Lead with humility:** Culminate by coming to understand that the leader is not expected to be the expert on everything or to monopolize all the power but is responsible for creating the conditions for the team to succeed as a whole.
2	**Embrace a true, authentic self:** Culminate by developing and leading according to a principle-based personal leadership philosophy.
3	**Act and speak with courage:** Culminate by performing the critical leadership functions to overcome resistance and produce change and movement that improves lives and situations.
4	**Develop and value people and resources:** Culminate by taking on the character of the global citizen and displaying the desire to serve as open-endedly as possible
5	**Empower and hold others accountable:** Culminate by using delegation, decentralization, and authority to create conditions to allow others to optimize their unique abilities, achieving results, not only from individual team members but also from the collective team or organization.
6	**Respect others by building trust and learning from mistakes:** Culminate by demonstrating inclusive leadership that embraces diversity and creates security, opportunity, and fulfillment for all.
7	**Serve others before self:** Culminate by expanding outreach and engagement from being with those closest to being with a much broader community.

Each Sunday evening, a Zoom meeting is held with the upcoming 3-4 student team leaders, the Habitat for Humanity site construction manager, and the course instructor to discuss potential construction tasks for Wednesday afternoon. This timing aligns well with the local Habitat for Humanity sites, which typically take Mondays off, leaving only Tuesday and Wednesday mornings for additional work before students arrive. Tasks are assigned during the meeting, allowing team leaders to prepare safety guidelines and material and method presentations for their teams. The site construction manager and course instructor provide feedback and adjustments as needed. Each member of the team is evaluated based on the statements shown in Table 1. Each criterion is evaluated on a '1-5' Likert scale survey ('1' indicating students strongly disagree with the statement and a '5' indicating strongly agree with the statement).

Outcomes Assessment and Lessons Learned

The course learning outcomes rely heavily on having an active construction site each week. Habitat for Humanity provides an ideal setting, as most workers are volunteers with limited experience, and the site construction manager oversees construction quality. Students have often corrected previous work to ensure quality, such as removing the siding to fix a connection that could allow water intrusion. This setup allows the instructor to focus on student outcome assessment while still contributing to construction quality.

A few years ago, the instructor would leave the site after students began work, leading to misbehavior and eventual dismissal from the site. Although this occurred near the semester's end and student outcomes were assessable (fortunately), significant effort was required to assure the Director of Construction it would not happen again. The instructor committed to remaining on-site during student activities to ensure proper behavior, address issues immediately, and assist with construction quality. This also enabled assessment of teamwork and leadership, which had not been evaluated before. The instructor now observes the full four-hour session to evaluate leadership, teamwork, and student interactions. Providing the Director with Field Reports, a "How-To Guide," and the leadership assessment process convinced them to allow students to return. Students are reminded they represent the university and are being evaluated on-site. The instructor's presence is essential for the project's success and the students' learning experience.

Despite knowing about the final Field Report, many students failed to build it weekly, leading to varying quality from exceptional to barely sufficient. To address this, the session before spring break will be held in the classroom, revisiting requirements and criteria. Students will draft their final Field Report, summarizing the first 6-7 construction days, with the earlier submissions in the appendices. This draft will be submitted before spring break to clarify any misunderstandings.

Similarly, students will submit a draft "How-To Guide" after working on it during the same session, ensuring questions are resolved with the instructor before submission. Additionally, students will receive mid-term leadership and teammate grades based on work from the first 6-7 construction days. While immediate issues are addressed on-site, this assessment provides an opportunity for students to adjust their behavior and develop leadership traits for the second half of the semester. Spring 2024 final presentations requested the students to reflect on the service aspect of the practicum. A summary of the key points provided by the students was as follows:

- Benefit others/community (6 students)
- Connect with people/community (5 students)
- Giving back to society (4 students)
- Safe/habitable homes (4 students)
- Trust/respect for the engineering profession (reputation) (4 students)
- Commitment to others (2 students)
- Inspires other volunteers to become engineers (2 students)
- Build peer relationships (1 student)
- Develop non-engineering skills (1 student)
- Collaborating with others (1 student)
- Realize what others do not have (1 student)

At the semester's end, reflections focused on themes like connection, benefit, giving back, reputation, and creating safe, habitable homes, without framing the practicum as a service project. This spring there will be a pre- and post-survey. The pre-survey provided the following key points from the summary of student comments:

- Half of the students have already worked with Habitat for Humanity because they gravitate naturally to "Build Stuff" community service.
- Many have been developing construction skills since high school.
- They appear to understand that little improvements each day leads to a big difference.
- Service provides critical insight into community impact.
- Most have added, or raised community service on their bucket list, but time can be an issue.
- Community service with Habitat for Humanity provides the unique opportunity to develop personal skills that can lead to huge future impacts on the job and within the community.

A summary of the student post-survey results for focus areas are as follows:

- Course Community Service Impact: Gained and applied critical skills to contribute to the community; increased awareness of the value of community service.

- Engineer Service Importance: Engineering is service while improving and protecting the lives of others; therefore, volunteering is what we should be doing.
- Service location on the personal to-do list: Most students reported an increased commitment to service, recognizing the tangible impact of assisting those less fortunate.
- Overall experience: Found value in learning through hands-on work, witnessing tangible progress in home renovations or new construction fulfilling and mutually beneficial.
- Construction Engineers suited for Habitat projects: Engineering students' understanding of key construction phases enhances the quality of their volunteer work.
- Best to lead service teams: The best leaders combine construction knowledge with leadership experience, value attention to detail, and embody selfless service.

A summary of community partner comments are as follows:

- Site Superintendent 1:
    - The Citadel's construction engineering class has been one of the best—if not the best—volunteer groups we've had on-site.
    - They consistently performed at an above-average level.
    - Their consistent presence allowed us to maintain continuity in our projects, ensuring tasks completed effectively or prepared for next group (< explanation).
- Site Superintendent 2:
    - Their solid foundation in construction principles, materials, and safety protocols allows them to quickly contribute at a higher-than-average quality level.
    - This often saves us time, effort, and even money.
    - We benefit from their creative problem-solving skills and fresh perspectives, which we can be passed on to other volunteers through their "how to" manuals.
    - This collaboration not only strengthens our construction efforts but also fosters a shared sense of growth, learning, and community impact.

Overall, students, faculty, and community partners recognize the practicum as having a positive impact on students, local community, and Habitat for Humanity.

Conclusions

The required ABET capstone (design, analysis, management processes) alone does not fully prepare construction students for their careers. The practicum offers invaluable hands-on experience, particularly for students without a construction internship, while even those with internships gain unique insights and expanded skills through Habitat for Humanity projects.

The daily Field Report, "How-To Guide," and team leadership assessment were vital in developing students into skilled construction engineers/managers. While students entered the course at varying levels, all showed significant growth, transforming theoretical concepts into practical skills, experience, and confidence as construction site leaders. Although much remains to be learned, they now have a stronger foundation to build their careers. Reflection assignments highlighted key outcomes such as: community connection, benefiting others, giving back, improving the engineering profession's reputation, and providing safe, habitable homes.

Maintaining a strong relationship with the host organization is crucial for sustaining these practicum opportunities. Once damaged, such relationships can be challenging to repair,

requiring measures like ensuring the instructor is always on-site. This presence mirrors OSHA's requirement for a competent person to oversee construction and safety, ensuring project progress and providing unbiased observations critical to student growth.

Meaningful projects like Habitat for Humanity house renovations and builds give students observable accomplishments, fostering reflection on quality methods, safety procedures, and leadership styles. More importantly, students apply their skills to serve the community, benefiting those less fortunate.

Community service organizations often need volunteers, and those with unique skills provide a win-win situation. Construction professionals, for example, can lead unskilled volunteers on Habitat for Humanity sites, offering guidance and oversight. The students may inspire more professionals to volunteer, strengthening the impact of such initiatives. The practicum's success depends on the cooperation of two Habitat for Humanity sites, which reserve Wednesday afternoons for the students. This flexibility allows the instructor to rotate between sites, ensuring students gain diverse experiences and adapt to construction schedules affected by weather.

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