Project-Based Service-Learning in an Undergraduate Course: Challenges, Lessons, and Recommendations

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This paper describes a case of project-based service-learning, handicap ramp construction, conducted within a six-week period with twenty-two freshman-level students as part of a typical construction management course. Aiming to share our experiences and lessons learned with the audience in the AEC discipline, this paper features the entire process of implementation of the project along with a few recommendations. The findings from the case are expected to provide useful guidelines for those who consider a service-learning project in a similar environment.

Key Words: Hands-on Experience, Project-based Service-learning, Construction, Education

Introduction

Both the academy and industry have recognized the need for and the efficacy of experiential learning in educating and training future professionals. Responding to that recognition, higher education adopted and implemented service-learning as a means of experiential learning decades ago. Various disciplines report that this learning mechanism benefits students' learning. Its benefits are broadly known for the following: (1) it provides students with an opportunity to apply, practice, and hone skills and knowledge obtained in the classroom (Martin and Haque, 2001); and (2) it fosters student's understanding of their responsibility to the community (Waterman, 1997).

The architecture, engineering, and construction (AEC) discipline also appreciates the significance of experiential learning for college students. For instance, the construction industry asserts that a hands-on approach to learning should be included in construction management curriculum (Fester and Haupt, 2004; Rapp, 2008). Furthermore, employers of the AEC companies prefer students with exposure to a combination of project and lecture-based education (Fester and Haupt, 2004). Some institutions, recognizing such a tendency, actively incorporate service-learning into undergraduate curriculum (Burr, 2001).

This paper presents the case of a service-learning project offered in a freshman level course of a construction management program. At Lamar University, freshman level courses provide an introductory experience for students in that early year of the construction management program. The service-learning project experience is designed as part of a typical introductory course wherein the primary subjects are materials, means, and methods for light construction. Despite trials and errors, students and instructor found the project an effective learning experience. The objective of this paper is to share our experiences with the educators in the AEC discipline. The paper features the entire processes of implementation of the project, from the development to the execution of the project, which are followed by discussion on the assessment of the results and the lessons learned. A few recommendations are also included as a result of reflection of the project. The detailed implementation process and recommendations will be useful to those who consider a similar approach.

Service-Learning in Various Disciplines

Regardless of discipline, there is a consensus of the perception of service-learning: service-learning is an effective educational tool to enrich students' learning and to foster their understanding and development of their roles and responsibilities in the community (Fredric and Reiher, 2001; Waterman, 1997). The National and Community

Service Act of 1990 defines service learning as an educational experience, rather than community service (United States Code Annotated 1999). Accordingly, in most cases of service-learning, two goals, service and learning, are pursued simultaneously in the context of service-learning. Whichever goal is emphasized more, learning occurs while participating students deliver their services. The learning process can be characterized by: "When individuals are involved in service-learning, they develop collaboration, problem-solving, and critical-thinking skills needed to become contributing members of society and successful learners. (Myers and Pickeral 1997)"

While most service-learning activities share many common characteristics, the following characteristics are unique to AEC institutions:

1. A completed AEC service-learning project is used by the community or individuals for a considerably long period of time.
2. The scale of an ACE project is comparatively large and complex, so that a project normally consumes considerable amount of time and costs.
3. AEC projects are normally conducted by a group of students rather than individual.
4. It is also worthwhile to note that a AEC service-learning project for the community is much different from a project conducted in the lab where the former involves a lot more uncertainty and risk than the latter.

When it comes to the development of a project, duration of a project is a significant factor to be taken into consideration. Based on its duration, a project can be classified into two types: a long-term project or a short-term project. A long-term project runs over a considerable length of time, such as a semester, a quarter, or a summer mini semester, so that it is normally implemented in a specially designed course for service-learning (Burr, 2001). Thereby, long-term projects can allow student participation at the university level. Meanwhile a short-term project is usually incorporated into a regular course and runs a relatively short time period. Participation, thus, is limited to students taking the course as part of their program curriculum.

Service-Learning Project: Ramp Construction

This section features the construction of the handicap ramp in four sub-sections —the initiative, project development, and preconstruction meeting, and project execution and control—that describe how the project was planned and conducted in detail.

The Initiative

Noting the aforementioned benefits of service-learning to students, project-based service-learning was pursued in the construction management program at Lamar University. Behind this effort, were the following premises: (1) incorporating a service-learning project early in a student's academic career will provide students with an opportunity to understand what domain knowledge and skills they need to achieve throughout the years of their study; (2) students can use the project to apply their knowledge obtained in the classroom through hands-on experience on a real project; and (3) the project can increase student's engagement with the community so as to foster their understanding of civil responsibility to the community, which will also help them build leadership.

Project Development

As the project unfolded, the challenge first confronted was the selection of an appropriate project suitable for a service-learning, term-project experience and other given conditions. Concerning the scale and complexity of work, a few potential projects—children's playground, dog houses, and a handicap ramp, among others—were evaluated by faculty of the program. In this selection process, a few factors—number of students (manpower), previous experience of students (knowledge), and the amount of time needed to complete the project (impact on course management)—were carefully assessed for each project. Since the project was part of a course, only students enrolled in the course (six female and sixteen male) were expected to participate. Being part of a course, the project inevitably involved a limitation—only very limited amount of time could be allocated to the project from the whole class schedule. As a result of assessment, a handicap ramp construction project was selected.

As mentioned above, the project was designed as a group term-project, aiming to facilitate team-based collaborative learning. From the point of academic learning, the objective of the project was two-fold: (1) students will practice their knowledge and skills learned in the classroom with regard to wood framing for light construction; and (2) students will be exposed to the fundamentals of planning and control of a construction project by conducting estimating, scheduling, and other project planning and control activities in a real project environment. It was envisioned that if successfully accomplished, the early experience would benefit students throughout the continuing years of study in the program by promoting their understanding of the program curriculum.

To satisfy the objectives, the project was adopted into a freshmen level course—CMGT 1320 Light Construction Materials and Methods, which is a typical construction management course comprised of lectures and labs. Each lab runs 1 hour 50 minutes (9:30 a.m. – 11:20 a.m.). The course focuses on the study of light-duty construction systems, with an emphasis on common building practices in residential construction. The course primarily is concerned with the technical aspects of various light-duty construction systems, such as wood framing for buildings. In this course, students are also expected to develop a fundamental knowledge base, to a certain extent, for managing construction projects through case studies and hands-on experience.

The success of service learning requires effective collaboration and partnerships with communities and community organizations (Knowerski and Nashman, 2002). From the beginning of project development, a long-term partnership with the construction-related industries was sought. As a result, a local construction material supplier agreed to provide all materials needed to build the ramp. This was a great help where cost often is a major constraint in many service-learning projects.

An important strategic decision emphasized in particular in this project was to challenge student's creativity and promote their autonomy in the decision-making process. For this, the instructor put much effort in creating and maintaining an environment that facilitated students' strong independence throughout the project. The aforementioned unique characteristics of a service-learning project in the AEC discipline may influence an instructor toward an obsessed desire for a successful project delivery. In particular, when a project has to be carried out by inexperienced young students, the instructor can easily be tempted to direct most tasks. Nevertheless, it was decided to let students commit mistakes so that they can learn through trials and errors.

Preconstruction Meeting (Lab 1)

The first lab conducted was a preconstruction meeting on the handicap ramp project. The entire class attended the meeting to study and overview the entire project, to review the conceptual design and site survey data, and to discuss management issues. One of the expected problematic issues was observed in the first meeting—the lack of participating students' knowledge and experience. A few approaches were attempted to overcome the problem before fabrication and installation began. The class visited two residential construction sites—although the visit was not solely for the project. During the visit, students were introduced by professional carpenters to actual practices for handling, fabricating, and assembling a wood frame. Video footage recorded from previous year labs in another course was also used, which showed operations for building two reinforced concrete foundations (2'x2'-1' thk) and a beam (12"x10"-16' long), including fabrication and installation. More details about wood work, such as the characteristics of materials and connection details were discussed in regular classes. Class schedule was coordinated between lectures and labs in order to prepare students in a timely manner. Thereby, students could build knowledge about means and methods for fabrication and installation of the ramp prior to the physical experience.

Various decisions for planning were made in the first meeting. The first decision was concerned with project organization. Similar to contractual relationships of real construction projects, the class developed the project organization illustrated in Figure 1, which provided guidelines for the roles of each group in the project. Team Building—assignment of students to each group—was directed by the instructor to take into consideration student's experience level, gender, and physical strength. Once project organization was completely developed, the project management team (PM) and foreman of each crew divided work to decide scope of work and develop work packages. At the end of Lab 1, homework was issued to develop a detail work plan, which included shop drawings, quantity take-off results, scheduling, quality and safety control plan, and resource management plan. For this assignment, the instructor provided a ramp construction manual and site survey data. Table 1 shows an example of students' work.

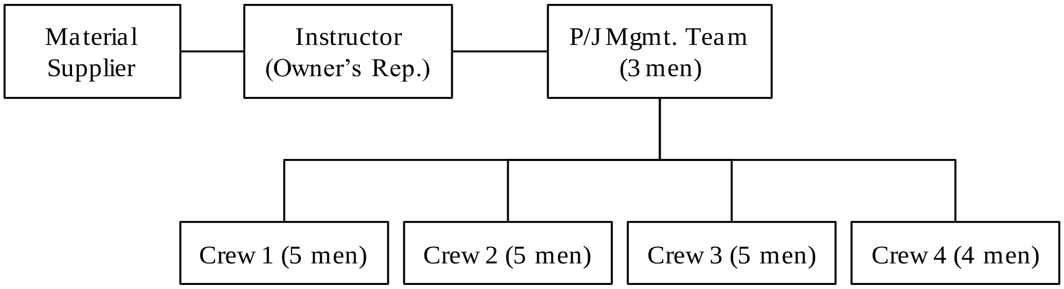

Figure 1. Project organization

Table 1

Example of Students' Work—Quantity Take-off (Platform #1 by Crew #4)

Description	**Quantity**	**Notes**
2x6 by 55" Joist	5	Cut joists and end pieces to length and assemble on flat surface.
2x6 by 58" End Pieces	2	Screw end pieces to the ends of joists with 3' screws.
1x6 by 60" Decking	10	Insure landing is square, and nail on joist hangers
2 1/2" Deck Screws	100	Flatten flange of corner joist hangers against end pieces of landing
2x6 Joist Hangers	10	Attach decking with deck screws
Joist Hanger Nails	100	

Project Execution and Control (Lab 2-6)

Primary field operations comprised fabrication and installation. Emphasizing, as noted earlier, student's autonomy throughout the period of the project, students were encouraged to make most of decisions on their own via coordination meetings among the groups (Figure 2). As a safety measure, PM was asked to report decisions made in the meetings to the instructor. The following presents how students managed the project by discussing the roles and responsibilities of each group according to the contractual arrangement of the project. Before Lab 2, each crew submitted its work plan—the results of homework—which was reviewed by the instructor and PM for approval. Throughout fabrication and installation of the ramp, the approved plan was implemented as a guideline to control the project.

Figure 2. Coordination meeting among students: PM was responsible for leading coordination among crews, and played the role of technical consultants similar to an architect or an engineer.

Table 2
Example of Students' Work—Summary of Daily Activities (Crew #1)

Lab Schedule	**Activities**
Lab 1 (2/3/2009)	In classroom, divided work into packages; PM signed the work for each group; and discussed methods for fabrication and installation.
Lab 2 (2/17/2009)	Selected all the pieces of lumber; cut all pieces for the post and the first part of the ramp; marked all the pieces of lumber with our group number; and cleaned the area.
Lab 3 (2/24/2009)	Took all the pieces of lumber outside; assembled the first post and the first platform; finished the first post and the first platform of the ramp; cut the pieces for the second post and platform; and marked our pieces of lumber and we cleaned the area.
Lab 4 (3/5/2009)	Finished the second platform and the second post; fixed the first post because we measured wrong and we realized that the ramp didn't fit on the post.
Lab 5 (3/17/2009)	Finished the last post; cleaned the lab; and discussed the day that we were going to the house to install the ramp.
Lab 6 (3/21/2009)	Transported all materials/tools; cut out the tree stumps to clear the way for the ramp; set string lines; began construction with the platform at the door; after the platform porch was built, started adding the other ramps and platforms; and finally built a slab.

(a) (b)

Figure 3. (a) Ongoing filed work; (b) Completed ramp

Progress control. PM developed a project schedule by merging each crew's schedule through coordination with foremen. The resulting initial schedule showed that the project needed four lab periods for fabrication in the lab and an 8 hour-long work period for installation on site. As it turned out, the schedule was a little ambitious. At completion (Figure 3), the project eventually took five lab periods in the lab and 11 hours on site. While performing the job, each group was required to record tasks performed each day on daily logs. Table 2 presents an example summary of daily tasks.

Quality control. Each crew created its own inspection and test plan (ITP) by using knowledge they acquired through lectures. Although the students' ITPs were very simple, they still listed essential quality criteria and tolerances for controlling major tasks. At each step of fabrication, every crew performed quality inspection according to its approved ITP. PM also used the ITPs to conduct quality control, mainly in the manner of audit, during fabrication.

Safety control. From the instructor's perspective, safety was as critical a concern as anything else. While each crew was responsible for its own safety, PM and instructor played the role of resident safety officer on site as they regularly conduct safety patrol. In addition, instructor and PM implemented a safety meeting, which is similar to the tool box meeting in practice, with the whole class at the beginning of each lab. Concerning security issues, students decided to complete fabrication in the lab; it was practically impossible to consider major fabrication on site because the site was too small and unsecured (Figure 3).

Resource management. In the project, materials were assumed to be furnished by the owner. To reduce wastage, PM, as a representative of the owner, managed inventory and each crew tracked material use. For the same reason, each crew was required to submit a request for material to PM whenever they needed to check out materials. At the end of fabrication, each crew compared quantity between its estimates and actual consumption with the intention to evaluate the accuracy of their estimates.

Document and information management. First of all, every form used for documentation was created by students. The forms were submitted by crews, and reviewed and approved by PM via consultation with instructor. According to contractual arrangement of the project, all instructions were issued by PM without instructor's direct involvement. For instance, when design change was needed, PM issued a change order and foremen communicated with PM. Only when PM found it necessary to communicate with the instructor would the instructor call a meeting with PM and foremen.

Lessons Learned

Reflecting what was learned from a project is crucial to internalize the experience (Senior 1999). After completion, the project was reflected over two lectures. Each group made a presentation, primarily discussing lessons learned and students' perception of the project. Majority of participating students evaluated the project as an excellent opportunity. The comments below made by a group in presentation well represent the positive feedback.

> "While conducting these activities, we gained hands-on experience on construction processes/operations of light wood construction. This project was an opportunity for learning the following: fundamental management practices at site engineer or superintendent level, analysis and interpretation of structural design as well as reading drawings, development of shop drawings and details for fabrication, and construction. We also experienced the significance of effective communication and coordination among project participants."

Meanwhile, students also identified the need for improvement in the following aspects: investigation and preparation of site prior to on-site installation; control of students' attendance for lab activities and on-site work; the lack of proper equipment; safety training and compliance; the leadership of PM; and the lack of instructor's direct involvement.

In addition to students' perception, the following summarizes a few notable challenges and lessons learned from the instructor's perspective.

Students' participation. Participation of students on the day of installation was low—among 22 students, 5 students (4 male and 1 female) did not show up and two students left at noon for personal reasons. At the end of work, there were only 12 students. As a result, it took 11 hours, instead of 8 hours to complete installation on site, plus an additional hour for minor tasks to close-out for a total of 12 hours. These absences showed it risky to expect all students participating in a project to practice maturity concerning behavior and attitude. In addition, the project was the first exposure to field work for many students, for which a big portion of the class could not find proper roles on site. It was regrettable that more careful arrangement of work should have been planned for such students to facilitate engagement of all students.

Weather impact. Weather conditions are normally perceived to affect performance of construction projects, which was also true with our project. Due to frequent rains in the coastal region of Southeast Texas, one of the difficult decisions made was the selection of the day, and the alternative days, of on-site installation. In addition, fabrication was also affected much by rain, which forced the work to be done outdoors, slowing progress due to the limited size of the lab facility.

Faculty commitment. As expected, the project required the instructor to contribute a considerable amount of time to the project. Working with students at the freshman level caused the success of the project to highly depend on the amount of instructor's effort on preparation of the project. Faculty should be well aware that managing such a project may easily requires much more time than the time for preparing regular classroom lectures and lab activities.

Autonomy and active learning. The demand on faculty commitment increases when students are allowed to exercise autonomy while conducting their work. Although it is a time consuming approach, it should be acknowledged that students become more active, responsible, and self-driven in learning when they are given autonomy. When students confronted a problem, the policy led students to exploring various potential solutions, which stimulated their intellectual curiosity and creativity.

Liability issues. Although the project was completed without experiencing any liability issues, there can be unexpected situations any time during the execution of a project. Therefore, liability matter should be consulted with university official. Two policies were implemented for the project discussed in this paper:

1. It was required for students to submit a consent of liability wavier. Students were informed of the policy in the first lab, which was about two weeks ahead of actual fabrication.
2. The construction management program purchased a Professional Liability insurance policy to cover faculty activities. This policy was made available through the Association of American Educators.

Recommendations

Based on observations and reflections on the service-learning project, this section presents recommended actions for those who may wish to incorporate a service-learning project in a similar context. These recommended actions, along with lessons-learned discussed earlier, are expected to contribute to improving instructional design and implementation of service-learning in the AEC discipline. The authors plan to apply the recommendations as well as the lessons-learned to improve current instructional design of the service-learning program, as explained below.

Begin well-ahead of time. It is highly recommended to initiate a project well-ahead of time, so that most preparation can be completed before the semester begins. By doing so, the instructor can design a project with a proper amount of time so that he/she can review even minor issues completely. If time allows, peer evaluation by other faculty members on the prepared plan is also recommended highly.

Secure materials and tools in time. It is necessary to order all materials at least a few weeks prior to the first fabrication day. If storage condition allows, one may consider completing the purchase of materials before the semester begins. Procurement administration can take much more time than expected. Furthermore, students' quantity take-off data is not quite reliable, particularly, if they are freshmen.

Prepare a separate set of policies for the project. One possible reason for attendance problems during this project was that the course policy did not address project attendance, so attendance became somewhat "voluntary." Unless it is possible to recruit a sufficient number of students, a voluntary-based project like ours is not recommended. If possible, it is a good idea to recruit students who have done a service-learning project previously. Concerning the control of student's attendance, i.e., manpower control in real project management, the minimum measure to be taken is to establish a separate set of rules and policies for the project. Attendance rule for regular classroom activities may not be effective enough to apply under the circumstances of the project discussed herein. The same action is also needed with regard to safety control. The policies should be a measure to promote equal and fair engagement and contribution of all participants.

Prepare all documents by instructor. If a project is going to be conducted by freshmen, there is a need for the instructor to prepare all documents, such as conceptual design, shop drawings, estimation data, and control forms. It does not necessarily mean the instructor's documents should be used, but those can be used as a reference. While it is a good exercise to let students create such documents on their own, the instructor should be ready to find those deficient to be used in actual process.

Set a formal communication procedure. Facilitating autonomy is meaningful, but risky at the same time. To handle this dilemma effectively, the instructor still needs to interact closely with students while promoting autonomous decision-making by students. In order to make it happen, instructor must have enough interaction with PM team and provide updates to all students at the end of each lab. Relying on student PM's leadership alone can also be risky—after all, they are also freshmen. To expedite effective communication among the student groups, the instructor may require students to exercise more formal communication and data exchange as if they are working in real projects.

For example, students may use request for information (RFI) as an official method for communicating new information rather than looking for spontaneous responses verbally.

Work closely with the university. It is recommended to coordinate with university officials from the development to close-out of a project. One notable outcome of effective coordination in our project was the arrangement of local media on the day of on-site installation. Two local TV channels visited the site and interviewed students. This attention dramatically raised awareness and appreciation of the project by the university members and the community, not to mention participating students.

Conclusions

This paper featured a service-learning project that was conducted as part of a typical construction management course offered to freshman year students. Despite considerable uncertainty and risk involved in the project, students delivered quality products without accidents. The greatest reward out of the project was that students found the project an effective, rewarding learning activity. Students stated that they enjoyed the project as an opportunity to apply and practice their knowledge obtained in the classroom. In the course of delivery of the project, students were exposed to various areas of the construction management discipline. Considering such successful outcomes, the presented details of our experiences are expected to serve as useful resources for those who are considering a similar learning activity. Furthermore, the discussed processes of planning and execution can be used as practical guidelines for managing such a service-learning project. In particular, lessons and recommendations discussed herein will be helpful to handle challenges—students' limited knowledge and skills, a tight schedule, and increasing demand of faculty's commitment—that such a project inevitably involves.

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