DIRECT AND INDIRECT SERVICE LEARNING IN CIVIL ENGINEERING EDUCATION

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ABSTRACT

Most of the service learning subjects are delivered in form of direct service, students participate directly in field work and reflect on the connection between community service and their academic learning; the benefits to the students and community cannot be manifested without the careful choice of project and detailed coordination of the faculty. Indirect service learning, on the other hand, students do not participate directly in field work, they understand the community through teachers, and can be more focused on applying their knowledge to address the needs of the community. The indirect service learning approach shifts the management of service learning from coordinating individual students' field work to managing students' group efforts on behalf of the community. Benefits and tradeoffs of these approaches are discussed in this paper; moreover, the nature of service required is another factor that should be considered when choosing between direct or indirect service. The author do not see direct and indirect service as mutually exclusive, rather, the faculty should consider an appropriate blend of the two to suit students' background and intended learning outcomes. An example of integrating direct and indirect service a service learning subject for civil engineering students is discussed in this paper.

Keywords: direct service, indirect service, civil engineering

1. INTRODUCTION

Outcomes of Engineering Education

In respond to the expectations our world display on future engineers, engineering degrees accreditation bodies such as ABET Engineering Accreditation Commission in the United States (ABET Engineering Accreditation Commission, 2013), Engineering Council in United Kingdom (Engineering Council, 2014), or Hong Kong Institution of Engineers (Hong Kong Institution of Engineers, 2013) have extended their set of learning outcomes that must be demonstrated by students graduating from engineering programs. Outcomes of engineering education should encompass foundational and technical attributes like science and mathematics, engineering analysis, design, some more professional outcomes are now included, such as ethical reasoning, societal awareness, environmental and economic considerations, and some personal, attitudinal outcomes also need to be addressed in engineering education. Not too surprisingly, these attributes are being translated into program outcomes in engineering programs, (for example, Department of Civil and Environmental Engineering, The Hong Kong Polytechnic University (2014)), and bring new challenges to faculty in view of the already packed curriculum.

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1.1 Approaches in Civil Engineering Education

Traditional approaches to engineering education have often been criticized for narrowly focusing on technical skills and not reflecting the social complexity of engineering practice. Despite engineering schools are often provided a high degree of institutional autonomy, nearly all engineering schools follows a highly similar, linear model. This traditional, linear model, linked tightly together by prerequisites and packed technical core courses – leaves little room for developing professional knowledge, skills, and attitudes needed by engineers. The traditional lecture-based approaches on engineering education have focused primarily on learning environments that facilitate the acquisition of foundational and technical skills, leaving the responsibility of professional skill development and the synthesis of skill sets to internships and other workplace experience (Mostafavi, Huff, Abraham, Oakes, & Zoltowski, 2013). As highlighted in Kolb (1984), learning is more effective when the development and synthesis of skills take place through an integrated process. However, neither ABET, Engineering Council nor HKIE have proposed clear implementation strategies to the learning outcomes.

2 SERVICE LEARNING

2.1 Definition of Service Learning

In Bringle and Hatcher (1996), service learning is a credit-bearing educational experience in which students participate in an organized service activity that meets identified community needs and reflect on the service activity in such a way so as to gain further understanding of course content, a broader appreciation of the discipline and an enhanced sense of civic responsibility. Strage (2000) considered service learning must include several critical components:

- High quality service that meets a goal defined by the community
- High quality learning: intellectual and personal growth of student
- Service and learning components of the course should enhance each other
- Service should be integrated into the fabric of the course by means of reflective and integrative assessment

2.2 Benefits of Service Learning

Generally speaking, service learning is increasing popular in higher education for its effectiveness in enhancing civic responsibility, acceptance of diversity, leadership skills; it has powerful impact of students' moral, social-cognitive and emotional development (Strage, 2000). Teachers reported that service learning bring new life to the classroom, enhances performance on traditional measures of learning, increases student interest in the subject, teach new problem solving skills, and make teaching more enjoyable. In addition, students in service learning sections had more positive course evaluations, more positive beliefs and values toward service and community. Moreover, it often has positive impact on personal, attitudinal, moral, social, and cognitive outcomes (Bringle & Hatcher, 1996). These benefits make service learning a very attractive pedagogical tool in facilitating the professional and attitudinal learning outcomes as stated in section 0 (such as ethics, social awareness, etc.).

2.3 Service Learning in Engineering Education

Albeit benefits stated above, while service learning has been well established in many displines in higher education, engineering has been slow to adopt the pedagogy (Zhang, Gartner, Gunes, & Ting, 2007). Engineering education has a science culture of intellectual impartiality and objective enquiry in which affect is ostensibly absent (Nesbit, Sianchuk, Aleksejuniene, & Kindiak, 2012). Luckily, the tradition on hand-on experience in engineering brings opportunities in filling the gap.

Evidence suggested that service learning experience influence student beliefs, and can be an effective pedagogy in instilling professional values/ ethics/ attitudes. Nesbit et al. (2012) reported the experience at a Canadian university, that community service learning experience facilitates the reconstruction of civil engineering student beliefs about both the type of work performed by civil engineers and the board impact of civil engineering knowledge.

Zhang et al. (2007) discussed examples on how to integrate service-learning into an already packed curriculum by replacing some of the coursework/ assessments by the service projects such that no significant truncation of course contents or time devotion by students. The authors discussed three examples at the University of Massachusetts Lowell with freshmen, junior and senior students respectively. The outcomes are encouraging; for example, it is reported that "students developed a better sense that engineers should use their skills to solve social problems facing their local community as well as communities internationally", "they have become more interested in pursuing a career that involves helping people", "they have become more comfortable working with people from different race and backgrounds" and "they have developed better relations with faculty members". In another case at a Canadian university (Nesbit et al., 2012), students performed small construction project, such as a fish smokehouse for an Aboriginal community, a play-house for a daycare center in an inner city neighborhood. The authors concluded that service learning experiences highlight for students (i) the importance of relationships between people, (ii) the value of variations in perspective, and (iii) the responsibilities of civil engineers in society as holders of expert knowledge.

Nonetheless, there are particular difficulties in introducing service learning into civil engineering education, due to the duration of typical civil engineering projects. Careful planning is always needed and it is crucial to find a right project of the right size and right topic so that students can complete within class time and be able to deliver the project to the community partner (Zhang et al., 2007). As noted in Bielefeldt, Paterson, & Swan (2010), it is difficult to implement project-based service learning in civil engineering, especially because "some infrastructure projects…for a community [have] a timeline to implementation longer than allowed in a single course or academic year. This complicated student involvement, reflection, and assessment in [project-based service learning]; an individual student may not witness the impacts of their work to the community and thereby undervalue the service-learning opportunity. In view of the project timeframe issue, in the EPICS (Engineering Projects in Community Service) projects at Purdue University, most service learning projects are not completed within a semester. The approach adopted was (1) definiting define specific deliverables for each semester based on which progress can be evaluated; and (2) maintaining and expanding the team roster throughout the project. The deliverables are progressive, and the collective set of deliverables is going to address the ultimate need of the community (Mostafavi et al., 2013).

3 DIRECT VS INDIRECT SERVICE

3.1 Drawbacks of Direct Service Learning

Traditional and the mainstream approach of service learning usually involve students participating directly in their community through some field work and students reflect upon their own experience after service. Scott (2004) commented yet much of the promises of [direct] service learning are not realized when courses are driven by (i) a "hyper-pragmatist ideology" (providing the best vocational training to prepare students for a successful career in a company) and (ii) set of institutional practices and structures. In service learning subjects, students often get to know the community partner in one week, and then have them to start developing projects the next week, producing proposals, progress reports, reflective journals, and presentations in a hasty manner. The complex, time-consuming tasks of a service-learning project leave little time for reflection, ethical intervention, especially when the project is initiated and completed within a semester. The hyper-pragmatist ideology may limit students' ability to consider the reasons for their work, students can easily get caught up in fulfilling their duties to the organization, pleasing their project sponsors not realizing they fail to engage their other stakeholder or consider the ethical implications of their work for these stakeholders.

In another study, Sturgill and Motley (2013) compared the outcomes of indirect and direct service learning in communication class. They also shared concern on time and scheduling conflicts. Courses with a service-learning component required on average 40 hours of on-site work over the duration of a course, but amount of time for students and faculty was a major drawback. One-shot projects that can be completed in a single semester are not always appropriate; it may run into a risk of no meaningful connection being established between the academic unit and the community. Communication issues and logistical mismatches inherent with service learning subjects cause stress for students. This stress results in push-back and a perception that the class is poorly organized. Faculty member worried about how this would affect student course evaluations, which are used as a career assessment tool. Sturgill and Motley discussed other drawbacks on direct service including: placing students outside the university can enhance legal risks, potential violation student rights to privacy, faculty lack control when students go to work in the community, service agencies/ sites may be unprepared for students' learning and service. At this note, Mostafavi et al. (2013) also mentioned the possibility of students' failure leading to difficulties for the community partner. It is necessary to make sure community partners are aware of the learning objectives of the projects and understand the process through which students learn from failures and maintain a careful balance between learning and community service.

3.2 Indirect Service Learning

Observing the downsides of direct service learning, Sturgill and Motley (2013) proposed indirect service as a possible way out. Connor-Linton (1995) described indirect service learning as students do not participate directly in field work, but they learn about some sector of the community through their teacher's own research and/ or community service. They apply knowledge acquired through the course to create a service or product which helps to meet a need of the community. Students can have more time to critically analyze the course content and social issues through the application. Changing to indirect service shifts the management of service-learning from coordinating individual students' field work to managing students' group efforts on behalf of the community.

3.3 Students' role in learning and outcomes

In the traditional, direct service model, students receive a broad range of information through several channels (visual, aural, affective) and must discriminate and order information relevant to their service role, the course content, and their personal development. While in indirect service, information is largely preselected by the teacher and presented through more traditional pedagogical channels (Connor-Linton, 1995). Nonetheless, indirect service learning is not passive learning. Information is largely preselected for its relevance to the community's needs and course contents, students can put more effort into applying their knowledge to analyze and meet the community needs. Sacrificing the immediacy of the student's community service experience enhances other pedagogical values of service learning, such as (i) greater ability to apply course concepts outside the classroom, (ii) teacher may be able to integrate team projects more concretely into coursework, (iii) greater control over student's experience, and (iv) possible to evaluate students' service effort: while it would be unfair in most direct service learning cases to evaluate students by the efficacy of their proposed solution for the community partner's needs.

Sturgill and Motley (2013) compared learning outcomes of two groups of communication students in direct and indirect service learning. Both groups of students were able to make connection between classroom learning to real-world application, able to do collaborative work; but the group of indirect service students were only able to think in general terms about the scope and value of their work for the community partner, but did not connect the value of their work to the outcomes for society; moreover, they have less obvious outcome of improvement in future citenzenship, civic engagement, and cultural understanding since they did not dealt with the society first-hand.

3.4 Type of service

In short, it has been discussed that direct service can bring along affective learning experience to students and deliver the associated outcomes more lucidly, at the cost of the time and coordination work, the potential risk of compromising the benefits of service learning, and less control on students' experience. Another aspect that one should look at before deciding between direct and indirect service is the type of service to be offered. Certain community needs are essentially needs of individuals, and direct student participation is appropriate, such as volunteer tutors in literacy programs. However, not all of a community's needs can be met by individual students (or small groups of students) working relatively independently. Some community needs are more system-level needs of social institutions (Connor-Linton, 1995).

4 BLENDING DIRECT AND INDIRECT SERVICE LEARNING

At the Hong Kong Polytechnic University, service learning is part of the graduation requirement of students. In each service learning subjects, it is expected students spend 40 hours in conducting direct service to the beneficiaries to ensure there is sufficient interactions to develop immediacy and affective component of the learning. Below is going to discuss the experience in a service learning subject in summer 2014 with a class size of 50 students (over 95% civil engineering major).

The subject was implemented in partnership with an elderly community center in a district that has predominately high percentage of old and low-income population. The primary beneficiaries of the project are the elderly residing in the district.

4.1 Subject outline

The subject was implemented in 7 weeks (summer semester) and roughly divided into three stages (Table 1).

Table 1 Subject structure

Stage	Weeks	Content	Individual Assessment	Group Assessment
Preparation	1 to 2	Lectures, seminars, and workshop introducing or reinforcing knowledge and skills that will be applied in service. Prepare students for service.	Assessments in online learning module	Pre- service case study
Service	2 to 6	Two service projects • Home Environment Assessment (HEA) : direct service • Age-friendly Community (AFC): direct + indirect service Regular groups meetings with project supervisors *(3 times, flexible schedule)* • Reflect on service experience, technical support from teachers	• 2 reflective journals • Individual service performance	• Study plan • Group service performance
Conclusion	6 to 7	Final presentations to beneficiaries Written report to community partner. Poster sessions to practitioners Final reflective report	Final reflective report	• Final AFC report • Presentation at community centers • Poster presentation

4.2 Service projects

Age-friendly community (AFC) project

In the age-friendly community project, groups of 5 students team up with the 3 to 4 healthy and active elderly to assess and provide suggestions on the age-friendliness of the district, based on the age-friendly cities concept proposed by the World Health Organization (World Health Organization, 2007). The teams of students cum elderly had focus group discussions and field visits. Part of the field visits were with the elderly so that students can obtain a first person experience of the problems; part of the visits were performed by students only, mainly for collecting some more technical data (such as measurement of vehicle flow, road width, air quality inside public transport). Students also researched on the relevant design standards and guidelines, case studies in other countries, and made references to what they have learnt in class to provide an objective analysis of the issues and propose solutions to the local authorities for follow-up. Lastly, students had presentations at the community centers to educate the elderly on the concepts of age-friendly community and present their suggestions. They also produce written reports to be submitted to the authority for follow-up. At the end of the project, students present their problem identification and suggested solutions in poster sessions, practicing engineers are invited to give comments to students to strength the academic linkage to their service.

Home Environment Assessment (HEA) project

In the home environment assessment project, students (in groups of 5) had three visits to the homes of the elderly who are living alone or as a couple. This group of elderly is less mobile and physically weak. Students examined the household environment and assessed the health and safety condition of the house (such as interior construction,

fixtures, electrical and fire safety). Apart from conducting the assessment, students chat with the elderly to show their care. The home environment assessment was intended to be an opportunity for students to understand and empathize with the old people who are frail and alone.

As described above, the two service projects provided a mix of direct and indirect service experience to students (Table 2). In these two projects, students established direct contacts with elderly of various education level, income, physical health and family conditions, allowing them to see the diversity of abilities and needs of the elderly population.

Table 2 Service Project and Direct/ Indirect Service Components

Project	Direct Service	Indirect Service
Home Environment Assessment	Home visits	-
Age-friendly Community	Focus group discussions Field visits Presentations at community centers	Field data collection Desktop research

4.3 Experience

As noted in Connor-Linton (1995), the impact of the age-friendly community project is more system-level rather than having some immediate benefit to the person being served, it is more appropriate to convert part of the service to the indirect mode. This particular service learning subject offered a mix of direct and indirect service learning experience to students.

Typically, the job of a civil engineer is very technical and has a very strong analytical focus, and these are reflected in the civil engineering undergraduate curriculum. Despite students acknowledged the ultimate contribution of a civil engineer is to build a better world for mankind, they are often unable to solid linkage between their academic learning and the needs of the end users. This lack of linkage is evidenced by students' doubts during the project meetings: some students raised that, they found the direct service components in the two service projects (home visits, face-to-face discussions, field visits etc.) may not be directly relevant to their curriculum, performing those tasks has nothing to do with enhancing their knowledge or skills in areas like structural engineering, construction material and so on. As discussed in section 1.1 before, this kind of doubts is probably due to the current civil engineering curriculum is overloading students with technical knowledge and skills, lending students to misconceptions what it takes to be a successful civil engineer; students who eventually become civil engineers may as a result focus too much on complying with the statutory standards and satisfying the client's needs (the party who pays for the projects), disconnecting themselves with the end users.

The purpose of this service learning subject is exactly to fill this gap. Relatively speaking, teaching new or reinforcing academic knowledge is not the primary objective of the subject, students are introduced contents that they need and they are expected to do some self-study. Rather, the direct service components of the subject offered a unique opportunity for students to understand how their profession impacts the well-being of the end users (elderly in this case), what are the deeper cause of their special needs (like deteriorating health conditions, low income), and thence reflect what they can do to help.

As a result of going through the 7-week of the service learning subject, by comparing the pre- and post-service student questionnaire, students demonstrated significant improvement in social responsibility (Figure 1 and Table 3).

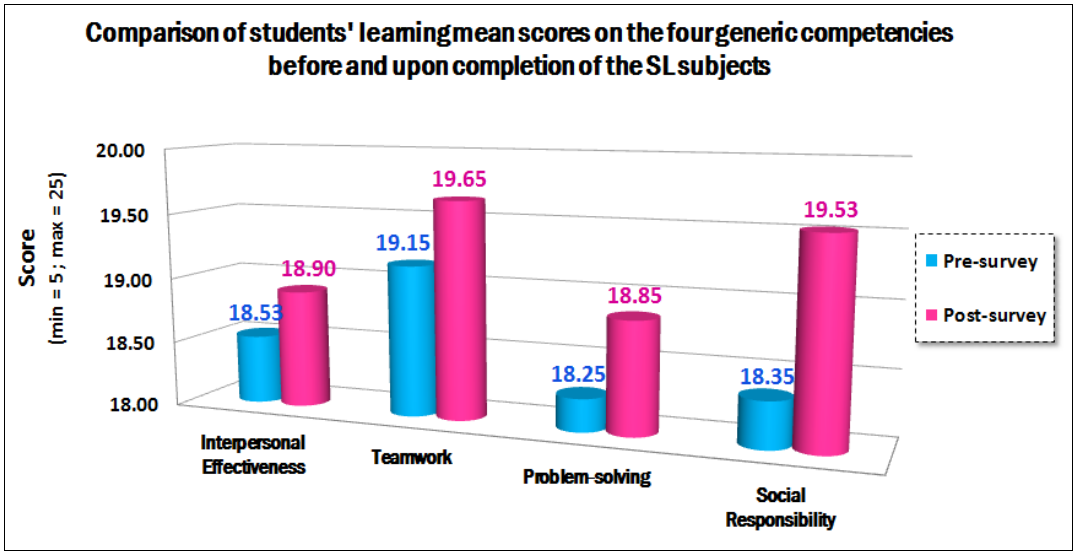

Figure 1 Comparison of students' generic competencies before and upon completion of the SL subject

Table 3 Comparison of students' generic competencies before and upon completion of the SL subject

Generic/soft skills	Students' SL Learning Status	Mean scores	Differences in mean scores	Sig. 2-tailed	Effect size
Interpersonal Effectiveness (IE)	Pre-SL Post-SL	18.53 18.90	0.375	0.469 (NS)	0.154
Teamwork (TW)	Pre-SL Post-SL	19.15 19.65	0.500	0.162 (NS)	0.250
Problem-solving (PS)	Pre-SL Post-SL	18.25 18.85	0.600	0.238 (NS)	0.217
Social Responsibility (SR)	Pre-SL Post-SL	18.35 19.53	1.175	0.013*	0.468

* Significance at the p=.05 level; NS – Not Significant

From the students' final reflective reports, nearly all students expressed the most important takeaway in the subject was they now have a much deeper understanding on the needs of the elderly, and how they can help as a civil engineer – simply following the design standard or current design practice is not good enough, if they can think a little deeper at the design stage, it can help the elderly a great deal. Moreover, most students also commented that this subject offered them a valuable opportunity to look at their community in a more microscopic perspective: they are now aware that small items like handrails, wheelchair ramps are indeed missing in a lot of public places, the pedestrian green light is actually too short, public toilets are not easy to find etc. These problems have always been there but they were not aware of it before, and now they can identify these problems easily and willing to offer help to people in need.

These are strong results supporting the benefit of combining direct and indirect components into service learning subjects for civil engineering students. The indirect service (data collection, desktop study) component maintains the academic relevance of the service projects, while from the direct interaction with the elderly, students learn how to see things from other stakeholders' perspective. The direct and indirect service components are complementing each other, allowing students to a build better connection between their technical knowledge and their service, they are able to

appreciate how (civil) engineering planning, design and cosntruction impact on the well-being of the elderly, and the larger community.

Last but not least, the community partner also benefited from the cooperation with students. From the feedback of the community partner, the depth of the research (resulted form the indirect service part) makes the final reports and suggestions more technically credible, and is more likely to be adopted by the local authority for implementation (compared with the suggestions made by their own advocacy group).

5 CONCLUSION

Contributions engineers can make to the society are often manifested through the utilization of the finished product, while engineers are often involved in the very upstream planning and design stage. To complement the highly technical, calculation intensive curriculum, use of service learning as a pedagogy can bring in the desirable learning outcomes such as ethical reasoning, social awareness, and competence in design meeting users' desires. Direct and indirect modes of service do not have to be mutually exclusive. Identification of suitable service learning projects and a suitable blend of direct and indirect service can on one hand highlight the importance of human element and in their profession, and retain a strong linkage between academic learning and service on the other. The above conclusion is drawn from the author's experience and artifacts of students' learning throughout the subject; it may not be representative at other institutions or disciplines. This case study may serve as an example that faculty can consider delivering service learning subjects in blended mode instead of struggling between direct or indirect service.

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