

# Engineering Design Solutions for Community Needs: Enhancing Undergraduates' Workplace Related Skills through Service-Learning

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## 1. ABSTRACT AND KEYWORDS

Service-Learning (SL) is a powerful educational tool that exposes students to the world of practice through well-structured opportunities for learning by doing. When SL subjects are developed for targeted students from selected disciplines, they can be used to enhance students' discipline specific skills. This paper presents the outcome from such an attempt to modify an open-to-all engineering-based SL subject to discipline specific SL subject. The key stages of preparation, execution and assessment of the SL subject have been modified to enhance students' workplace related skills. The results of the questionnaire survey and the reflective writings done by the students reveal that, when carefully designed, SL subjects can effectively be used to enhance students' workplace related skills. The challenges faced and strategies for sustainability are also discussed.

Keywords: Service-Learning, Workplace Skill Development, Engineering Design

## 2. INTRODUCTION

The Hong Kong Polytechnic University (PolyU) has a long tradition of offering Service-Learning (SL) subjects with the objective of enhancing students' social awareness and civic responsibility (C.K. Lau, 2016). The mechanical engineering department of PolyU offered its first engineering-based SL subject titled, 'Engineering Design for the Community' in year 2014. Main objective of the subject is to serve the underprivileged community in the Hong Kong society using engineering design and related skills of undergraduates while enhancing their civic responsibilities. Several researches have pointed out that SL has contributed positively in changing students' attitude and awareness of their role in the society as responsible learned members (Cheung Min Alfred Chan, 2014; Jacoby, 1996; Ngai, 2006).

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While satisfying the core learning outcomes expected from a SL subject, the subject management team explored the possibility of enhancing students' workplace

related skills (professional skills) through this SL subject. There are other similar attempts reported in the literature (Hansen, Muñoz, Crist, & Gupta, 2007; Malinin, 2017). This paper reports the methods we adopted, problems encountered, successes and future improvement directions. This could be a good case study for those who aspire to add more value to their SL subjects.

### 3. SUBJECT DETAILS AND PROJECT DESCRIPTION

The SL subject, ‘Engineering Design for Community’, is first developed as a general education subject that is available to all PolyU students. Each semester it enrolls around 60 students (120 per year) to engage in local service learning projects. Roughly, 70% of students are from engineering disciplines and the remaining from non-engineering disciplines. They are formed into groups of 4 members; each group consisting of both engineering and non-engineering students. Each student group is introduced to a client with a need that can be satisfied through an engineering design solution. The student group then go through a systematic design process where they identify the need, develop concept solutions, test the selected concept, redesign/modify and finally deliver appropriate product solution to the client. The subject management team collaborated with several elderly care homes, and community organisations to reach the underprivileged people with needs.

There are 4 distinct components of the SL project; preparation, execution, reflection and assessment. The preparation phase consists of classroom lectures, training workshops, guest lectures, and self-phased eLearning. During the execution phase, student groups have several meetings with the client to identify needs and then develop a suitable design solution which is implemented. The project provided them an opportunity to serve the community while providing them with a valuable opportunity to acquire new academic and professional skills through an experiential learning process. Figure 1 shows some of the customized design solutions developed by student groups.



Figure 1: Selected customized design solutions developed by students

Students from the non-technical disciplines made valuable contributions for each group in the early stages of the project. However, it was noticed that they are more

passive and lack the skills to contribute for technical aspects of the project that needs more manpower and time commitment. This has negatively affected the team dynamics, service project outputs and the learning gains of the students. Considering the long-term sustainability of the SL subject, the subject offering has then restricted only for engineering and design disciplines.

#### 4. OPPORTUNITIES FOR WORKPLACE SKILL DEVELOPMENT

With the change in the student composition, the subject management team explored the opportunities of adding more value to the student learning outcomes. During the 4-year university life, engineering undergraduates are mainly engaged in academic training. They get limited opportunities to interact with outside world and real-life problems.

However, for engineering disciplines, workplace skill development is one of the major expected programme learning outcomes. It is one of the aspects critically evaluated by the professional accreditation bodies for programme accreditation. Currently, in Mechanical Engineering programme, final year capstone project is the major learning activity that focuses more on workplace skill development. Being an experiential learning module, with appropriate modifications, SL subject can also be used to impart essential workplace skills. Seeing this opportunity, new changes have been introduced for the preparation, execution, and assessment stages of the subject focusing more on professional practice while achieving service-learning goals.

**Preparation:** (1) General practice of group formation for SL projects has been changed into a formation of a design company serving under-privileged community. Students are trained to play the role of professional engineers and managers. (2) Training on art of communication with elderly and disabled by invited professional social workers (3) Providing experiential training at the community centers.



Figure 2: Experiential Training at Community Center

**Execution:** (1) Students play the roles of expert engineering designers at clients' site. (2) Use of professional project management techniques in managing time, and resources. (3) Providing the opportunity to work with different stakeholders of the project such as service recipient, social workers, technical experts, marketing

personnel, fellow teammates, and consultants. The teaching team, technical staff and invited physiotherapist served as consultants to projects.

**Assessment:** (1) Assessment of students' professional performance during the site visits through direct observation. (2) Reflection activity on individual's professional performance and skill development.

A questionnaire survey was conducted to solicit students' self-assessment on the improvement of their workplace related skills. Forty-eight valid questionnaires were returned. More than 90% agreed that the SL subject enhanced their awareness of professional ethics and social responsibilities. Over 80% of the students agreed that their leadership and communication skills have improved. (see Table 1).

Statement	Strongly disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Strongly agree (%)
1. This SL subject helped me to enhance my skills in using computational tools necessary for design/engineering practice.	0	0	29.2	43.8	27.1
2. I am now more skillful in searching appropriate information for learning independently using variety of educational media	0	0	22.9	45.8	31.3
3. I am now more skillful in coming up with different strategies and options for dealing with complex social and technical issues	0	0	14.6	50.0	35.4
4. This SL subject enhanced my ability to function professionally in a multidisciplinary project team as a team member	0	0	6.3	60.4	33.3
5. I am now more confident in playing leadership roles in multidisciplinary project teams	0	4.3	14.9	59.6	21.3
6. This SL subject enhanced my awareness of professional ethics and social responsibilities of an engineer/designer	0	0	8.3	47.9	43.8
7. This SL subject helped me to improve my oral communication skills (technical presentations and general communication with peers, collaborators, and service recipients)	0	0	18.8	52.1	29.2
8. This SL subject enhanced my written communication skills	0	2.1	25.0	47.9	25.0

Table 1: Summary of survey results (N=48)

Some of the reflections from students provide evidence of how they acquired/enhanced professional skills through this SL subject:

"Service learning not only makes me realize that I can use relevant professional knowledge to help the community in need, but also enhanced my skills, such as communication skills, creative thinking and industrial production techniques. During the process of service learning, I realized that my knowledge on technology is inadequate. If I want to be an effective professional engineer, I need to improve my knowledge and skills in different aspects and work cooperatively with other professionals. In addition, after service learning, I realized that there are lots of underprivileged people in our society and I have a responsibility to make a change in their lives using my professional knowledge"

"The challenge I faced as a project manager and a member of my team was to ensure 'equality'. I wanted everybody to feel like a part of the team. I managed to guide my team to complete the project successfully. I think I have uncovered one of my hidden talents; I am a leader. I also developed my critical thinking skills to solve challenging problems systematically. Now I am more confident in taking up challenging real-life problems"

## **5. CHALLENGES AND WAY FORWARD**

The modifications made to the service project demanded additional resource commitments. For manpower requirement, the teaching support team has been expanded from 2 members to 7 members (5 teaching staff + 2 teaching assistants). In addition, 2 student helpers were recruited as mentors. Financial support has been secured from a donor arranged by PolyU Office of Service Learning through a competitive process.

One of the unexpected challenges is the management of expectations of the service recipients. In several instances, inexperienced students, while playing the expert engineers' role, have overpromised the deliverables. Some student groups found it difficult to deliver the solutions they promised within the set deadline and budget limit. Learning a lesson from it, students were taught to 'under-promise and over-deliver' to manage client expectations in a more professional manner.

Knowing that the service project is a learning activity for the students, some service recipients wanted to keep students happy and motivated by appreciating their work without giving honest opinion about the design solutions being developed. They have revealed the problems only after the projects were completed and requested modifications later. The teaching staff then had to attend to those needs by themselves. It is hard to find a solution for this situation as it is a cultural habit of people in Hong Kong. Problems could be minimized by making students

aware of this situation and training them to use multiple ways to test the suitability of a design solution.

Some of the sustainability challenges are retaining the same staff or the core staff members in the teaching team, securing continuous supply of financial support, finding suitable projects with appropriate opportunities to develop professional skills, etc. Maintaining high percentage of successful service deliveries is one of the key factors in addressing those challenges. That will keep all the stakeholders enthusiastically engaged with the SL project.

## 6. CONCLUSIONS

When designed carefully, engineering SL projects provide an early opportunity to expose undergraduates to professional working environment and enhance their workplace skills. The effectiveness of the workplace skill development through SL subject 'Engineering Design for Community' is evident from the questionnaire survey results and the reflections provided by students. The major drawback is the high level of resource demand. If resource supply can be sustained, engineering SL subjects can successfully be used for students' workplace skill development.

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