Service-learning Experience for Engineering Students at Ngee Ann Polytechnic

Andy Lee Chung Hong* and Mei Feng

* School of Engineering – Mechanical Engineering Division, Ngee Ann Polytechnic, Singapore

lac5@np.edu.sg

Abstract

Service-learning is a form of experiential learning, where students approach a community, strive to understand their needs, and apply their domain knowledge and skills to solve the problems faced by this community. The interaction with the community also provides students the opportunity for active participation, learning through human interaction and building of character through teamwork such as developing a sense of responsibility and gratitude – values which are difficult to nurture using classroom teaching practised in many engineering courses.

In addition, through engagement with the community and learning about their issues, students learn to apply what they have been taught in class in a meaningful context, and gain competencies relevant for their future workplace such as developing critical thinking and problem-solving skills.

This paper describes the experience encountered during the inaugural service-learning project called “Engineering for a Good Cause (EFGC)” held in 2016 which saw participation by thirty Ngee Ann Polytechnic (NP) students from School of Engineering, Mechanical Engineering (ME) Division.

Introduction

Ngee Ann Polytechnic (NP) values the holistic development of the students. Students are encouraged to not only attain academic excellence, but also to apply the knowledge learned in the classroom to the complex situations in a real-world setting (Ngee Ann Polytechnic, 2016).

Service-learning is a pedagogical method that helps students gain a thorough understanding of the complex problems in a community, and challenges them to use critical thinking along with practical application of learned materials to solve those problems.

Striving to address human and community needs, students are also able to build a sense of connection and commitment to the community. Service-learning nurtures an environment where students can contribute to the common good of the society, especially by helping the disadvantaged populations in the country, and gives them a chance to re-evaluate their personal values and motivations.

With this goal in mind, the Mechanical Engineering Division of the School of Engineering at Ngee Ann Polytechnic (NP-ME) partnered with Engineering Good (EG), a non-profit organization that provides opportunities for engineers to contribute their expertise to address the needs of the disadvantaged communities in Singapore and neighbouring regions.

NP-ME collaborated with EG to organize a service-learning experience for their Year 2 Engineering students called Engineering for a Good Cause (EFGC). Students worked alongside with their lecturers and volunteers of Engineering Good to brainstorm ideas on how to run this event with their engineering skills.

This paper will describe the EFGC event, discuss the outcomes and review the students’ learnings out of their experience.

Planning and Execution of EFGC 2016

The aim of EFGC 2016 was to raise funds for EG to support its projects and operations as well as to provide a platform for NP-ME students to apply their engineering knowledge and skills to practical use for a good cause.

The event was held on July 5th, 2016 and consisted of the following activities:

1) Selling of souvenirs to raise fund for EG
2) Tic-tac-toe game with robotic arm
3) Toy repair auction to repair and modify toys for children with special needs.

**Selling of Merchandises**

EFGC 2016 merchandises were designed and fabricated using Computer Aided Design (CAD) software and manufacturing processes such as 3D printing and laser cutting. Besides applying technical skills learnt from their course of study, the students also exercise their creativity and ingenuity in designing the items and stretching the capabilities of the fabrication machines. Booths were set up to display and sell these merchandises to raise fund.

Figure 1. Merchandises sold at the EFGC 2016

**Tic-Tac-Toe Game with Robotic Arm**

NP-ME students used their knowledge of programming to program a robotic arm to play tic-tac-toe with donors, priced at S$1 per game. To entice donors to donate more, the students came out with the idea to give back S$5 if they can beat the robot in the tic-tac-toe game.

Figure 2. Donor (left) trying out the tic-tac-toe game. Poster (right) designed by student to give incentive to donors if they can beat the robot in the tic-tac-toe game.

**Toy Repair Auction**

NP-ME students also conducted a toy repair auction to repair used toys and modifying them into interactive toys with large switches that can be operated easily by children with special needs. The young beneficiaries are from AWWA (Asian Women’s Welfare Association), a local non-profit organisation that provides community-based programmes and services to people of all ages, in particularly those with special needs and disabilities (AWWA, 2017).

Donors will donate money to fund the repair of the toy of their choice. The toy repair will commence when the target amount of S$50 has been reached. Besides raising funds and bringing joy to the children, this activity has helped the students apply their electrical and electronics, problem-solving and trouble-shooting skills in a real-world setting by repairing and modifying the toys for children with special needs.

Figure 3. An interactive toy with large switch that can be operated easily by children with special needs.

From the sale of merchandises, tic-tac-toe game and toy repair auction, a total of S$2279 was collected from EFGC 2016. All the proceeds were given to EG to fund their projects and programmes.

**Review of EFGC 2016**

According to Robert Shumer (2007), service-learning provides opportunities for the holistic development of students beyond the academic realm by exposing them to experiences that challenge their intellectual and moral schema. For EFGC 2016, while students were able to make use of their engineering knowledge and skills to raise funds for EG, the entire service-learning experience may not have fulfilled all the criteria necessary for high quality service-learning programmes by Shelley Billig (2004) as follows:

1) Clarity of service-learning objectives
2) Linkage between service and academic curriculum
3) Interaction with community
This paper has hence proposed their respective mitigating measures to make for a more fruitful EFGC 2017.

Clarity of Service-Learning Objectives

In Singapore, almost all local students would have experienced at least 60 hours of community service in their primary and secondary school years through the Community Involvement Programme (CIP) which aims to build social cohesion and inculcate civic responsibility in them (MOE, 2014). The CIP aspires to help students develop a strong social conscience, and a sense of belonging and commitment to their community, society and country.

CIPs are usually led by their teachers and are finite in duration. The types of volunteer work for CIP include activities such as peer group tutoring, tending to the eco-garden, maintaining school facilities, making handicraft to raise funds for a beneficiary, helping out in welfare homes or teaching senior citizens computer skills. These community services are conducted to fulfill the minimum CIP hour requirement and generally do not include specific learning objectives or organized reflection and extension opportunities.

A review of the EFGC 2016 shows that while students had benefitted from a strong connection between service and academic curriculum that was demonstrated, the clarity of service-learning objectives and interaction with community were found lacking. Hence, when students participated in EFGC 2016, they had the initial perception of doing the volunteer work to fulfill school or co-curricular requirements.

Students were challenged with the notion that EFGC is not merely a typical community service but service-learning, which is a student-driven process, where students learn about a particular issue or problem faced by a community and apply their academic knowledge and skills to address the community needs. Students were expected to take the lead in conducting research, identifying problems, brainstorming for solutions and writing proposals under their teacher's guidance.

However, the concept of community service as mainly fulfilling the CIP hour requirement is much ingrained in students. To shift students' mindsets that service-learning is different from community service as it demands a more proactive role is one of the key challenges encountered during the first run of EFGC 2016.

To overcome this challenge for subsequent EFGC runs and to correct students' perception so that they are better placed to derive maximum benefit from a service-learning project, students will be briefed on the difference between community service and service-learning:

- Hopkins (2008) defined community service as volunteering in the community for some form of extrinsic reward, such as fulfilling a graduation requirement or obtaining class credit.
- In contrast, Bringle and Hatcher (1996) defined service-learning as a course-based, credit-bearing educational experience in which students participate in an organised service activity that meets identified community needs and reflect on the service activity in such a way as to gain further understanding of course content, a broader appreciation of the discipline and an enhanced sense of civic responsibility.

Linkage Between Service and Academic Curriculum

Scheckley & Keeton (1997) described experiential learning to be superior than the conventional lectures as “it leads to greater depth of processing of concepts”. This avenue for learning arises when there is a disconnect between students’ new experiences and their prior knowledge: which results in students undergoing a reflective thought process to utilise their present knowledge to make sense of the newly acquired ones. Such active learning is more powerful than the traditional lectures as students derive at the knowledge themselves, as opposed to being fed the same knowledge by the teacher.

David Kolb (1984) defines learning as “the process whereby knowledge is created through the transformation of experience”. According to Kolb, learning is continuously grounded in experience between the person and the environment. In this process, the onus of knowledge construction falls on the learner as opposed to the teacher.

These theories suggest that in service-learning, intentional connections must be made between participants’ prior knowledge gained in classroom and current service experiences. In addition, service-learning may not lead to strong intellectual development if the prior knowledge and temporal understandings are not present. It is imperative that service-learning projects must be customized to suit the different courses undertaken by students.

Hence, to ensure effectiveness, the EFGC service-learning project was designed in accordance to the learning needs of the participants who are engineering students.

Therefore, the manufacturing processes using 3D printers and laser cutting machines were chosen with the intention to allow students to apply their knowledge in Computer Aided Design (CAD) to produce EFGC’s customized merchandises such as acrylic engraved key chains, name tags, photo frames, handphone holders, identity or dog tags and mug coasters. This is done with the goal to enable students to make meaningful connections between what they have learnt in the classroom and extend their knowledge and skills to produce customized products to raise funds for charity.

Through this process, they attained a better understanding of the engineering principles learnt. The hands-on sessions enabled them to apply their knowledge in the real world. This form of active learning is far more effective than the kind of learning which Freire (1970, 1973) describes as the “banking method” of education whereby students accept “deposits” of information from teacher, and spit them out again in exam.
Interaction with Community

Interaction with community in service-learning can be either direct or indirect:

- The direct approach involves interactions between the students and the recipients. Common examples include tutoring needy children or helping the elderly.
- In indirect approaches, there are no interactions between the students and recipients - e.g. students may help a community indirectly by raising funds for them. Nonetheless, indirect service-learning experiences may take place at the service site. Examples include repairing park benches or beach cleaning.

The type of service-learning has a bearing on its impact to the students. A study by Coomey and Wilczenski (2005) revealed that students generally benefitted more from direct service-learning as opposed to indirect service-learning. This is because students derived more empathy and gained a better sense of purpose when they have interacted with the recipients who would benefit from their services.

EFGC was conducted to raise funds for Engineering Good that aims to enable engineers to utilize their engineering knowledge to improve the lives of the disadvantaged communities. Through interactions with Engineering Good volunteers, students understood that they were raising funds to support its operations. However, students did not have the opportunities to interact with the communities supported by Engineering Good. For example, students involved in the toys repair auction did not get to meet the special needs children and observe what type of toys would suit their needs or how the children would be playing with repaired and modified toys.

Hence, this indirect service-learning approach is less impactful to students. Moving forward, for future EFGC runs, direct service-learning approach will be advocated and students will get the opportunity to visit the disadvantaged community and learn to identify, propose and implement solutions to help solve problems faced by the community.

Benefits Gained by the Students and Beneficiary from EFGC 2016

Service-learning has been shown to enhance student engagement. Melchior (1999) and Shumer (1994) indicated that students typically become more engaged in learning as evidenced by motivation to learn.

The questionnaire survey conducted upon conclusion of the EFGC 2016 indicated that students found the EFGC to be a rewarding experience:

“EFGC has helped me to use my engineering knowledge to repair toys and being able to repair stuff on my own is a useful skill to possess.”

Ignatius Yong, Year 2 Engineering student

This was reflected in the feedback by Ignatius Yong, a Year 2 Engineering student, said that he has gained a deeper understanding and appreciation of the electronics principles learnt in school through repairing toys for EFGC.

In addition to improving academic performance, service-learning also helps to provide students with opportunities for social and emotional learning. Students learn to work in teams with other students of different personalities and working styles and discuss ideas in a constructive manner to arrive at a conclusion, i.e. identification of the issue faced by the community and its resolution.

“This has helped to boost my interpersonal skills through communication with donors at the event.”

Trinh Dang Khoi, Year 2 Engineering student

The abilities to collaborate with diverse people in teams and to articulate their ideas clearly are valuable assets that will stand them in good stead in their future jobs upon graduation. Trinh Dang Khoi, a Year 2 Engineering student, was grateful for being able to improve on his communication skills through interaction with donors at EFGC.
Figure 6. Teamwork displayed by students in achieving a common goal

Figure 7. Trinh Dang Khoi (far left) stepped out of his comfort zone to approach donors for EFGC 2016

Moreover, students also develop a greater sense of civic responsibility for the community at large and empathy for the disadvantaged. The students realised that they are very fortunate and should not be taking what they have for granted; and this sense of thankfulness translates into a more positive attitude of the students in other aspects of their lives, such as learning and relationship with their family and friends. Billig (2002) found that students who participated in service-learning reported greater levels of behavioural, affective and cognitive engagement in school than their non-participating peers.

All donations collected from EFGC 2016 were subsequently given to Engineering Good to support their operations, projects and programmes. On the local front, Engineering Good’s project partners include Cerebral Palsy Alliance Singapore (CPAS) and AWWA School. Through these collaborations, equipment could be created to enable CPAS students to conduct science experiments with an eye to bolster CPAS’ existing teaching materials that could be shared with other special needs schools across Singapore; and likewise, develop assistive technology for special needs students at AWWA School. In the international arena, projects with community-based organisations ensured that the Sre Chea Commune and Kampot province in Cambodia have access to clean water; while a children’s home and school will be constructed in Bohol, The Philippines – an area struck by the 2013 earthquake, to name a few.

Conclusions

Service-learning has been implemented in schools in advanced countries worldwide as it is proven by research to be a powerful tool in the holistic development of students beyond academics. In addition to providing a better understanding of the principles learnt in school through real world application, it serves the community while stretching the personal, social and emotional growth of students in the process. Ngee Ann Polytechnic endeavours to continue with service-learning for our students so that they will be well-equipped with the academic knowledge and practical know-how, as well as the requisite soft skills in teamwork and presenting oneself, together with a sense of civic responsibility, to contribute to society at large.

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References


