Flood risk reduction initiative: A service learning project by engineering students

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Abstract. This study examined the influence of a small-scale service learning experience on engineering undergraduates. The aim of this study is to test the potential of service learning to develop social responsibilities, soft-skill competencies, engineering design self-efficacy and risk attitude of engineering students. Our results suggested that conducting a service learning flood risk reduction initiative increase learning and help to develop the necessary hard and soft skills to address community needs.

1. Introduction
Disaster education is usually not taught in higher education except in disaster management and healthcare course [1]. The effectiveness of disaster-related subjects in undergraduate programmes other than programmes in environmental studies and healthcare has not been properly evaluated. Post-disaster response and recovery provide an excellent learning opportunities for students [2]. Aftermath of disasters create windows of opportunity for change, promote sustainable development and disaster risk reduction [3]. Sixty four percent of total world population exposed to floods each year live in South Asia [4]. With increased vulnerability due to rapid urbanization, environmental degradation and poor governance in developing nations in this region, it is important to educate our citizens who may be deployed or volunteer to help in the post relief and recovery efforts. Even though natural disasters like flood cannot be prevented, we can reduce the risk of impact of disaster by taking preventive measures. Disaster education and early warning system can reduce the disruptive impact of disaster on communities.

The advancement and convenience of mobile apps for travel purposes, budget-travel tools and attractive mobile deal promotions increase the number of budget youths travelling abroad [5,6]. Asia is an immensely popular travel destination for young, budget-minded travellers but the Asia-Pacific region is also one of the most disaster-prone areas in the world. Therefore this increases the level of exposure of youth visiting disaster-prone Asian countries with frequently occurring natural disasters such as earthquake, tsunami, typhoons and flood. It is through educating youth and students of higher education in disaster risk reduction that students travelling abroad to high risk locations understand the risks they may face and what they need to do to mitigate disaster risks. Students need to be made aware of the need to keep safe, disaster early warning services and evacuation plans as part of disaster risk reduction in the event of occurrence of future disasters. Disaster education also will benefit the disaster-stricken people they may happen to help at the disaster sites as tourists.
The inclusion of disaster risk reduction in educational institutions and school curricula emphasized the implications of risks associated with disaster and create awareness in people to be mindful of policy or development that may lead to the creation of an environment with higher vulnerability to disaster risks. Therefore, schools students need to be taught risk identification and evaluation. Project Learning Tree developed an education model called Focus on Risk which emphasize risk education for students in Grade 9th to 12th using a variety of learning activities and tools [7].

Accreditation Board for Engineering and Technology (ABET) outcomes set forth by Engineering Accreditation Council Malaysia (EAC) include 3 types of skill development and learning outcomes: psychomotor, cognitive and affective domains [8]. One of the outcomes include developing knowledge, skills and attitude to assess environmental impact of engineering projects and risk identifications and apply risk treatments to ensure safety, reduce uncertainties and negative impacts. It is not sufficient to develop intellectual skills in risk analysis and management but to place an equally important emphasis on “risk attitude” [9]. Hilson et. al [10] define “risk attitude” as the “the chosen response to perception of significant uncertainty”. Students must be able to sense, be aware of and identify possible risks and evaluate trade off where possible. Higher education must continue to review effective educational tools to provide opportunities for risk management learning and risk attitude cultivation.

Engineering students need to apply critical thinking skills to real world problems and recognize the importance of risk management in engineering design, development of policy and organizational responses and decisions [11]. Therefore, it is becoming increasingly apparent that capacity building and education training in the field of risk management is needed to avoid unforeseen risks and contribute to sustainable development and robust society. For this reason, risk management and education need to be included in higher education courses through which students can be trained as risk managers. To reach a large number of student university-wide, courses that expose students to safety engineering and disaster risks are needed. Learning approaches such as problem-based learning, case study, internship, project based field exercise, service learning and specialized modules by integrating concepts of disaster risks into their existing course and syllabi have been adopted [1,9,12]. In Japan, Osaka University designed a new environmental risk management training to train environmental risk managers by cooperating with other local universities through faculty exchange, credit exchange system, joint seminars and research collaborations [9].

In New Zealand, the University of Canterbury in Christchurch responded to 2010-2011 earthquake by introducing a service learning programme that involved students in community recovery projects [13]. Students from Stanford University and Syiah Kuala University jointly collaborate with the Indonesian Ministry of Marine Affairs and Fisheries to support community rebuilding after the devastating Indian Ocean tsunami 2004 as part of Stanford University international service learning project [14]. The presented examples have involved students provided service to the community allowing students to apply knowledge to solve real life community problems and deepen their understanding of natural disaster risks.

Service learning has been defined as “a form of experiential education in which students engaged in activities that address human and community needs together with structured opportunities intentionally designed to promote student learning and develop reciprocity and reflection are key concepts of service learning” [15]. Exposure and participation in service have the potential to stimulate helpful behavior and increase in social responsibility attitude of students. Service experience in risk and disaster education is able to empower youth to serve and support disaster recovery efforts. Participation in service allow students to have hands-on experience of the impact they can have on others when dealing with local natural disasters and with an increased continued commitment to volunteer in the onset of future disaster and not feel helpless [1].

In this research, we explore whether a small scale (16 students) service learning experience had positive impacts on student development of social responsibilities, soft skill development, risk attitude development and engineering design self-efficacy. It was a learning experience for the engineering students because students are able to achieve one of the course objectives by applying critical and
problem-solving skills in designing flood mitigating prototypes for school students. Engineering students had the opportunity to use engineering design process through which hands-on demonstration models were designed adopting the various design stages from identification of problems, conduct background research, develop possible solutions, selecting the best options, construct a prototype, test, redesign and evaluate design solutions and communicating the solutions to school students [16]. Engineering students also had the opportunity to develop non-technical skills such as communication and teamwork, project management skills and increased sense of responsibilities to serve the society. It was a service experience because students worked with schools to build resilient communities and raise STEM awareness in school students.

Flood hazard in Malaysia contributes to 98.7% of annual average losses compared to other hazard. The northeast monsoon season from November to March brings heavy rain to the east coast of Peninsula Malaysia. In December 2014, prolonged rainfall resulted in disastrous flooding particularly in the East Coast of Malaysia. Thousands of houses and businesses were inundated – characterised as the worst in Malaysia natural disaster – hundreds of thousands were forced into relief centres [17]. He recommended disaster awareness programme be conducted for those affected by monsoon flooding. The United Nations has also called for disaster risk reduction to be included in school curricula around the world to raise disaster preparedness and awareness among students and their immediate family members [18]. For this reason, we conducted flood risk reduction science activities for primary school children because children has the ability to influence disaster preparedness knowledge and behavior of their parents [19]. Researchers have reported children positively influenced their parents in learning basic computer skills, transfer of environmental knowledge, attitudes and behavior [20, 21].

2. Methodology
In this service learning project, engineering students worked with 60 students from Year 5 and Year 6 in a school during school hours at a school Sekolah Kebangsaan Batu Kapur in Temerloh. UTAR students made a) a hydraulic pump to transfer water from low lying location to a higher location b) a watershed and floodplain model c) a floating home. Primary school students collect data to explore flood proofing homes and how to better prepare for flooding. The hands-on science demonstration project as part of the engineering students’ community project was designed to develop primary school children’s interest in science and other STEM (Science, Technology, Engineering & Math) content area and to prepare students for STEM-related career and to help students better prepare for flooding.

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2.1. Course and participants
The context for the disaster risk reduction service learning was a soft-skill undergraduate course entitled Community Project. The course objectives are 1) to enhance students’ practical experience in organizing and preparing community project 2) to develop social responsibilities skills by expanding network 3) to serve the community with knowledge and skills acquired by students in their curriculum. Sixteen engineering undergraduates out of 120 students from Universiti Tunku Abdul Rahman (UTAR) students registered for the module offered to take up the disaster risk reduction service learning experience.

2.2. Procedures
Students participating in the service learning project attended few sessions of meetings: 1) two 3 hours sessions of lecture facilitated by Community Project lecturer to learn about principles of community development, community asset mapping and project management 2) meetings to discuss the logistics of the project 3) the 3 hours hands-on flood science demonstration and activities in school 4)
debriefing session facilitated by lecturer in which students were asked to share their service experiences.

2.3. Measures

Five point likert scale survey was used to quantify level of agreement on the achievement of course learning objectives and to assess the impact of the service learning project on development of risk attitudes, engineering design skills, social responsibility and soft-skills in engineering students. All 16 students responded. The questions for this study were adapted and based on evaluations of service learning projects at other engineering departments of institute of higher education. Students were asked free response questions and ordinal questions with following responses: “Not at all”, “To a small extent”, “To a moderate extent”, “To a large extent”, “To a very large extent” which were coded from 1-5 respectively.

We developed a five-item likert scale measure of based on applying soft skills based on Robles [22], and development of social responsibilities based on Canney & Bielefeldt [10]. We assessed students’ belief how well they can use engineering design process using engineering design self-efficacy through five-item likert scale based on Carberry et al [24]. Self-efficacy refers to an individuals’ judgment of their capability to organize and execute courses of action for a given task [25]. The risk attitude survey was adapted based on Carvalho, Dong, Tumer, & Van Bossuyt [26].

3. Results and discussion

The learning objectives were divided into 3 subcategories: applying soft skills, developing social responsibilities, and using engineering design skills in building flood-mitigating prototypes for school students. As summarized in Figure 1-3, the service learning community project has measurable impacts on student attitudes in all three aspects of learning objectives. In addition to achievement of the three course learning objectives, one of the objectives of this project is to cultivate ‘risk attitude’. A summary of the data can be found in Figure 4. Out of the four course objective categories, student development in the area social responsibilities and soft-skills appears to be performing better than other areas. See Figure 1-4.

When asked about the service learning experience in the free response question section, students reported the following: 1) “the enthusiasm shown by the school children had made the service learning more enjoyable.” 2) “Doing background research of what types of prototypes to be designed and built for hands-on demonstration was a very good experience. I enjoyed learning from others” 3) “meeting the needs of community have brought great satisfaction” 4) “learning new skills to serve the community is fun”

![Figure 1. Service learning contribution to development of student social responsibilities.](image-url)
Students participated reported an increase in their social responsibilities’ skills and soft-skill competences. This finding is consistent with previous work. Simon & Cleary [27] studied students who had service learning experience with community partners and found that service learning contributed to students’ personal and social development [27].

Student cultivation of risk attitude and engineering self-efficacy had the lowest rating. Guntzburger [12] cited that there was a surprisingly low publications on risk management in engineering education. He further commented that it is essential to develop safer engineering practices and improve systems’ safety in engineering education. Since students are first year engineering students with little design experience, it is expected that engineering design self-efficacy was low because engineering design
self-efficacy is dependent on engineering experiences. Professors and engineers have significantly higher engineering design self-efficacy compared to undergraduates and individuals can build up their self-efficacy through opportunities that provide engineering design mastery skills [25].

We suggest some improvements to the course delivery. Students enrolled in this community project soft-skill based course had undergone a few lectures of community project management but they did not receive training in engineering design process to tackle complex societal problems and sustainability design methods. It is desirable to include the service learning approach into academic curriculum and student research projects involving students and faculty members from different multidisciplinary background. Students can hone their design skills in developing prototypes by interactions with non-academic stakeholders by identifying and researching design needs (lowest score in engineering self-efficacy as shown in Figure 2). Actual design projects in the real world involves a variety of stakeholders from diverse background [28].

Students need opportunities to learn out-of-classroom skills, creativity and problem-solving skills not only during normal times but also after disasters. This project leverage service learning and community project for disaster risk education complementing other service learning for disaster risk reduction initiatives and post disaster recovery.

We find that the service component of the project provided meaningful service to the school students and enhance their interest in STEM subjects and increased flood science knowledge and disaster preparedness. The primary school students were enthusiastic of the university students’ efforts.

4. Conclusion

The objectives of community project soft skill course offered at Universiti Tunku Abdul Rahman was to develop student soft skill and social responsibilities. As compared to the usual community social work as practical field experience, we suggested two groups of engineering students to do something different by implementing a service project that teach primary school students disaster risk education. Students gained knowledge and information on hazards, risk and vulnerability while at the same time applying science and engineering to build resilient communities. Reducing environmental risks requires both policy and local individual action. Disaster preparedness is not just the responsibility of the government and disaster managers but also of every member of the community. With a knowledge of risks and vulnerability, young engineers can better prepare themselves to meet societal needs and to volunteer in the aftermath of disaster.

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