Service-Learning Remotely: Lessons from Delivery in Humanitarian Engineering During the COVID-19 Pandemic

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ABSTRACT

CONTEXT
Service learning plays an important role in developing globally minded engineers who are more socially engaged. This paper reviews lessons learned from the development and delivery of an undergraduate final year elective in humanitarian engineering, focusing on experiences drawn from working with industry partners and the transition to online delivering during the COVID-19 pandemic. The unit of study forms the culminating class for students completing the Humanitarian Engineering major at the University of Sydney.

PURPOSE OR GOAL
Service-learning pedagogy has seen increasing uptake by engineering programs aiming to broaden learning outcomes. For the growing field of humanitarian engineering, service-learning has been a core pillar of how programs are delivered. However, previous research has highlighted the potential risks posed by humanitarian engineering fieldwork and sustainable funding to support international placements is precarious – limiting the number of students who can engage, and potentially, the longevity of such programs. This work aimed to identify best practice in remotely delivering service-learning projects, including their potential to improve student engagement during online delivery.

APPROACH OR METHODOLOGY/METHODS
We use case study methods to examine lessons learned from the development and adaptation of collaborative industry partnerships as part of a series of service-learning projects over three years. Drawing on student evaluation data and unit of study materials, we draw out important considerations when designing international service-learning projects. We cross examine yearly changes to curriculum to identify the impact of pedagogical shifts in delivery and their impact on student learning.

ACTUAL OR ANTICIPATED OUTCOMES
Our results demonstrate the importance of collaborating industry partners not only for the sustainability of service-learning efforts in communities, but also as a medium to expand understanding of the professional context of work with low-income and marginalised communities. We also discuss the benefits of service-learning to partner organisations and communities – namely the development of leadership roles and challenging engrained practices.

CONCLUSIONS/RECOMMENDATIONS/SUMMARY
The post-pandemic environment offers an opportunity to critically evaluate service-learning delivery modalities and test new methods. Our approach shows promise as a means to scale access to international opportunities for students while mitigating potential negative risks to communities.

KEYWORDS
service learning; humanitarian engineering, COVID-19

Introduction

The use of service-learning has seen significant growth in the field of engineering education (Bielefeldt et al. 2010), providing a model for engaged educational delivery. Bringle and Hatcher (1996 p. 222) define service learning as *"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 as to gain further understanding of course content".* The rise of service learning in engineering programs is at least partly an extension of a signature pedagogy (Shulman 2005) focused on project-based learning.

For the consolidating field of humanitarian engineering, service learning has become a core pillar of its identity. The socially engaged focus has been heralded as a pathway to improve gender diversity and equip engineers to meet increasingly complex and interdependent global development challenges (Smith et al. 2020). However, while much of the focus of humanitarian engineering has been on *exposing* students to the principles of socially responsible engineering, there remains comparatively less focus on *'how'* engineers will be asked to perform these roles professionally. Attracting a diverse cohort humanitarian engineers is no doubt a positive shift, but we need to mobilise and translate this empathetic form of understanding community needs into action. There is a growing disconnect between the passionate cohorts of students pursuing these education programs and career pathways available to them (Litchfield and Javernick-Will 2016). The workplaces that await socially engaged engineering students upon graduation may not match expectations, at least in part, because of how we deliver content – a gap that has yet to be fully explored in engineering education research.

A second, and equally important question surrounding pedagogy of humanitarian engineering is its sustainability – both its social (e.g. Birzer and Hamilton 2019) and economic dimensions – for students and the communities served through curriculum collaborations. Traditionally, the delivery of content has relied on extracurricular activities (e.g. Engineers Without Borders), small and costly modules (e.g. overseas field schools), or through knowledge external to university institutions (e.g. guest lecturers). These characteristics are not necessarily unique to humanitarian engineering, but they do perhaps represent a higher percent of content delivery as compared to other disciplines, placing the attainment of learning outcomes at risk when disruptions arise. There is a need to interrogate and assess how service-learning is delivered, not only to shape more effective learning outcomes, but also ensure the longevity of efforts to train engineers capable of addressing the needs of marginalised communities.

This research aimed to examine pedagogical approaches to better align humanitarian engineering curriculum and practice. We first provide a brief overview of service learning as a pedagogical approach, humanitarian engineering as an emerging field, and gaps in current knowledge in engineering education at their nexus. We then present a case study of the development and delivery of a final year humanitarian engineering elective over three years to explore learning outcomes and lessons from working alongside industry partners to shape student experiences.

Methods

We adopted a descriptive case study approach as our aims were process-oriented (Case and Light 2011; Yin 2018). There are relatively few humanitarian engineering depth (as opposed to breadth) electives currently offered in Australia, and even fewer that have been offered for multiple consecutive years. We (both authors) draw on our own experience in the delivery of a unit of study to examine the pedagogical approach, student feedback, and lessons relating to the delivery of service-learning in an established humanitarian engineering program.

The Case: Engineering for Sustainable Development

The University of Sydney currently offers a major to engineering undergraduate students (Thomas et al. 2017). The major is designed around four subjects taken in a student's third and fourth year of study. The first unit of study is a third-year introduction to humanitarian engineering (CIVL3310), which provides a broad overview of global development institutions, relevant standards (e.g. Sphere), and the role of engineers in addressing the Sustainable Development Goals. Students are also required to complete a Global Engineering Fieldwork unit of study (CIVL5330), which involves an overseas placement, and a breadth elective. The breadth electives include a range of relevant topics including Understanding Southeast Asia (ASNS2665), International Project Management (PMGT3857), Global Poverty and Education (EDUF3026), and Disaster Relief Operations (ITLS6007). The fourth unity of study, Engineering for Sustainable Development (CIVL5320), provides further depth which builds upon concepts covered in the introductory Humanitarian Engineering (3310).

This case study will focus on the development of the final year unit, CIVL5320, which forms the culminating class for students completing the humanitarian engineering major. The class was first offered in 2018 and has subsequently been offered in 2019 and 2020. The unit of study intends to provide engineering students with an understanding of principles of engineering for sustainable development. Topics include the history of international development, project tools for working with developing communities, and exploration of current trends in areas of global development practice. Material focuses on the application of engineering in marginalised communities which address complex and uncertain problems using systems thinking, inter-disciplinary approaches, partnerships, and policy. Upon completion, students should be able to:
1. Understand the history and legacy of engineering in development and humanitarian practice.
2. Converse in and critically examine sustainable development theories, frameworks, and debates.
3. Develop sustainable engineering solutions using incomplete or limited data from multiple sources to address complex social, economic, and environmental challenges facing developing communities.
4. Apply engineering toolsets to needs assessment, project planning, monitoring, evaluation, and learning (MEAL) in developing community contexts.
5. Choose participative approaches and tools in project planning, implementation, and evaluation to inform more inclusive engineering designs.
6. Convey engineering analysis to multi-cultural audiences to inform effective technical solutions and policy recommendations.
7. Employ appropriate teamwork skills across project phases to address development challenges.
8. Apply ethical and appropriate judgement in development practice while introspectively examining positionality.

The unit of study was developed with a strong service-learning pedagogical approach. Students work in small teams over the duration of the semester on an engineering design to address a real problem facing a community, with industry partners acting as a bridge between students and communities. The first two years the class was offered involved multiple partners, allowing students choice in their projects. In the last year considered in this case study (2020), a single partner was used, and students worked on the same project. Previous partners have involved non-governments organisations, foundations, and engineering firms with projects located in Afghanistan, Indonesia, the Philippines, Samoa, South Africa, and the Solomon Islands. Examples of projects have included the design of a community water system, a bridge feasibility study, flood control assessments, improvements to brick production for safer earthquake construction, and improving medical equipment maintenance systems.

In 2020, the unit was offered entirely online due to the COVID-19 pandemic. The content remained largely unchanged from the first two years of delivery, giving an opportunity to assess the learning outcomes and lessons from delivery which still used an underlying service-learning approach, but relied on remote interactions.

Findings

There have been several lessons from the iterative development of the considered unit of study. Foremost, both students and industry partners reflected in evaluations that it wasn't just the service-learning component alone that led to positive learning outcomes, it was situating this within real-word project boundaries. For example, one student commented, "*This subject teaches engineering in the context of the real world - it's invaluable to learn how to deliver a real project to real people rather than an assignment for marks.*" Another student mentioned, *"I think the project was perfect for our skill level and gave an excellent introduction into what a career in humanitarian engineering could look like."* One way this was accomplished was by ensuring that student teams were paired with an industry partner who served as a focal point of contact, but still in the context of a 'community'. This assisted in both logistically coordinating across diverse international project locations with a responsible level of oversight, but also served as an exposure opportunity to professional norms.

An added benefit of using multiple types of partners was greater student awareness of the differences in the operating practices across industries (e.g. non-profit vs consulting firms). However, in 2020, only one partner was used out of necessity due to demands of transitioning content to online delivery in the pandemic. While there was some diminished benefit in breadth of exposure, a single project for all student teams was found to provide an opportunity to explore specific technical, social, and cultural dimensions in greater depth. This also assisted in streamlining logistics in coordinating assessments.

A consistent theme that emerged across multiple cohorts of students is the value they placed on accountability. A student commented, "*The final project was a great experience. Having the freedom to think critically and design solutions on our own – and be accountable for those solutions – was really rewarding.*" Much of this was anchored through assessments that aligned with chronological project tasks throughout the semester, guiding students through a project cycle from start to finish in a compressed, but realistic timeline.

Students have overall been receptive to the unit of study approach. Table 1 shows a summary of unit of study evaluations and enrolment numbers for the three years of offering.

Table 1: Unit of Study Survey (USS) Evaluations

Year	Enrolments	USS Score	School	Faculty	University
2018	21	4.79	4.16	4.03	4.10
2019	11	4.61	4.15	4.03	4.11
2020	16	4.78	4.06	4.01	4.11

Note: Evaluations shown on 5-point scale.

Discussion

Our findings have several implications for both theory and practice. Foremost, we need to be careful assigning uniform meaning to 'service-learning' – there are multiple pedagogical orientations that can emerge under this umbrella. While past literature has often placed importance on students working directly with a community, our case study shows that students often retain a socially engaged identity benefit without this direct interaction and there may be similar benefits to working with partner organisations. This is promising for

considering how humanitarian engineering programs might be scaled. At present many universities currently rely on overseas field placements to achieve similar learning outcomes. There are examples of remotely managed relationships, such as the Engineers Without Borders Challenge offered to first year students, but few of these exist at later candidature stages.

One of the primary criticisms of humanitarian engineering pedagogy is its reliance on international placements (Birzer and Hamilton 2019; Vandersteen et al. 2009). While the student projects in this case were not immune to negative impacts that others have previously raised, relying on established organisations who are working in communities mitigated many of these risks. The academic debate has often focused on the lack of benefit to communities – what surfaced through multi-year partnerships was that there were benefits, but perhaps not what might be expected. It was often not the technical solutions, but rather student's line of inquiry and questions which led to organisations and communities to questioning engrained practices.

In our case, the customer community members themselves derived several non-technical benefits. The currency of the in-country staff of the partner organisation was significantly boosted in the eyes of the end-customers. This was especially important for the partner organisation's technical staff who, in another time and place, would qualify as expert engineers. They were sometimes viewed as glorified handymen by the customers or implementers of imposing Global North institutions. Being associated with an Australian university significantly boosted their self-confidence in a culture where so much authority relies on "face". This, in-turn, boosted the confidence of the customers in the technical solution design and brought benefits in the community engagement process.

As questions come through the students and the in-country technicians provide answers, the technicians also were validated in their knowledge. They perceived – correctly – that knowledge sharing is a two-way path between the Global North and Global South. These staff expressed value in knowing that they were supporting education of engineering students. Industry organisations often reflected on this brought a true sense partnership with communities that was not easy to achieve without the student cohort.

While our case study does not provide a direct comparison between learning outcomes achieved through in-person and remote service-learning projects, it does take an initial step to demonstrate the potential role of the latter. We are not suggesting that community placements be replaced by remote project experiences. Immersion activities have undeniable importance for cross-cultural experiential learning. What we are suggesting is there is a need to more closely examine *where* learning outcomes are best achieved. Given the cost and time required to deliver overseas fieldwork units, it is important to identify where comparable learning outcomes can be achieved.

Conclusion

We have presented a case study of a final year humanitarian engineering elective, examining lessons on the development and delivery. Our results advance understanding of service-learning pedagogy and its evolving role in humanitarian engineering programs. We raise the importance and potential of industry partners to both mitigate identified risk for students working with marginalised communities and expand understanding the professional context of career pathways. Ours results offer recommendations to those seeking to expand humanitarian engineering programs or applying service-learning models in engineering curricula.

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