Reconceptualizing Online Experiential Learning: Case Study of a Tele-engineering Project

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***Abstract*—This case study illustrates the design of an international engineering Service-Learning project adapted for a hybrid-mode implementation, where the academic learning takes part mostly online and the service component entirely online. We share lessons learned from the experience with the online teaching community and Service-Learning practitioners on how technology can be leveraged for civically engaged teaching and learning online with innovative lesson planning, even for hands-on engineering projects.**

Keywords—tele-engineering, solar energy, international eService-Learning

I. Introduction

Energy poverty, or the lack of access to electricity and other basic energy services, affects nearly two-thirds of Sub-Saharan Africa [1]. This creates a vicious cycle for impoverished individuals, as they are the least likely to have access to power and they are more likely to remain poor if they are not connected. As Africa seeks to free itself from an energy-constrained future, pressure mounts for building a sustainable system in face of a growing climate crisis. Access to electricity and global climate change are inextricably linked, therefore it is only apt that one of the SDG goals, i.e., SDG7, is to achieve affordable and clean energy for all. This also sets the backdrop for the exploratory case study in this short paper, where we share the design and implementation of a cross-disciplinary green engineering project in Rwanda as part of a Service-Learning (SL) course that had to be taken online due to the coronavirus (COVID-19) outbreak.

SL is a teaching and learning strategy that integrates meaningful community service with instruction and reflection to enrich the learning experience, teach civic responsibility, and strengthen communities [2]. While SL is a well-established experiential learning pedagogy, eService-Learning (eSL) is an emerging practice and some believe it to be a promising medium for delivering the 21st-century skills that students need to succeed, including information literacy, ICT, innovation, and career skills. Yet when the COVID-19 pandemic struck, many traditional SL courses around the world failed to transition online and were either canceled or relegated to desk research. This is perhaps not surprising as experienced traditional SL practitioners often lack the toolkit to rewire the experiential learning experience to be delivered effectively online, and established online instructors may not know how to incorporate SL into their courses [3].

This case study contributes to the literature by demonstrating how online experiential learning can be reconceptualized to make students' virtual understanding of energy poverty and socially responsible global citizenship tangible and relevant via innovative online learning and service. The University in question has a long track record of designing and carrying out renewable energy projects on the African continent. Past projects have built up a framework that blends service to the community with capacity building [4]. COVID-19 rendered overseas travel impossible and put a stop to these projects; yet at the same time, at the target community service site in Rwanda, the social distancing measures, including school shutdowns, exacerbated the energy poverty issue: since internet access is unreliable in many communities, some schools resorted to teaching on radio [5]. However, even a radio requires electricity, which is not a given in many communities. Hence, the decision was made to conduct the project remotely, via a *tele-engineering* mode.

The rest of the paper proceeds as follows. After an introduction of the project background, we go into details on how the various course and project components were adapted for online teaching and service. We also go in-depth on how various digital tools were leveraged to create connectedness among students to the community they serve. Lastly, we share lessons learned and insights gained for practitioners who are looking to take their SL courses online, especially for those in the engineering discipline.

II. Project Background and Design

Our case study is a leadership program that spans two semesters called *Habitat Green in East Africa.* The program focuses on global leadership and cultural sensitivities in the context of cross-disciplinary green engineering, appropriate technology, and sustainable living. It consists of students from three SL subjects in the University. Through this program, they learn about the concepts of socially responsible leadership and intercultural competencies and demonstrate these competencies in practice. At the same time, they also learn about different principles of green engineering, sustainable development, and

appropriate technology, and practice and demonstrate these concepts in a service project in East Africa. Specifically, they work with local peers to design and develop green energy solutions for families in remote villages. Students under previous variations of the program have been going to Rwanda since 2013 to conduct a service project that revolves around installing solar energy systems for homes in remote villages and wiring them for electricity.

Fast forward to today, COVID-19 has brought offshore SL projects at the University to a halt due to social distancing and travel restrictions. However, civically engaged teaching and learning can still go on. When physical interactions with peers and communities are not feasible, technology can be leveraged in an innovative and human-centered way to make a "high-touch" engineering service project work. After careful planning and preparation, we adapted the current iteration of the Habitat Green program to what the eSL literature considers as a mixture of Type I (instruction online, service on-site) and Type III (instruction *and* service partially online) eSL [6].

Specifically, the teaching, course discussions, and experiential learning activities were conducted mostly online, but when it came the time to physically build the solar energy systems, students were asked to come back to the lab and work with teammates face-to-face. The service, on the other hand, will be fully online (the service component is scheduled to be carried out in August 2021). During lab, students were asked to install modular solar systems which were then packed and shipped to Rwanda. Each student team was also asked to produce a training manual with instructions on installation and troubleshooting, supplemented with training videos. During the online service component, students will first train the local youths on installation in Rwanda via Zoom. After equipping them with the necessary skills, the local youths will then travel to the villages and install the systems for 150 households over the course of one week. During the installation, our students will join via online calls to offer assistance remotely should the youths run into problems. In total, there were 60 students enrolled in the three subjects under this iteration of the program.

When we set-up the eSL course mentioned above, the following principles were considered:

1. Determine which components of a course are suitable for teaching face-to-face, and which for teaching online. Develop an effective timeline to give students the opportunities to realize the intended learning objectives.
2. Leverage online tools to cultivate a sense of connectedness among students beyond the usual Zoom, Teams or Google Classroom meetings, keeping in mind that it takes multiple sessions/activities to build up rapport.
3. Assess community partners' capacity for online collaboration, offer support in areas they may struggle with when the service project takes place online.
4. Involve the community partner early on in the course. Students often gain civic knowledge from direct interaction with the community, but since they cannot travel for the service interactions can be arranged online pre-service.

III. Project Implementation

Next, we detail the key components in the project's implementation that are essential during the three stages of the eSL course. The first stage of the course design is to build up students' knowledge in course concepts and their competence to work effectively with others. Then we deepen their understanding of social issues via experiential learning activities. Lastly, they are allowed to turn awareness into action by serving the community.

A. Student Rapport

Apart from the frequent in class online discussions, we organized a virtual team-building activity to reinforce student interaction. They were divided into teams of 3-4 to compete in an online "Amazing Race" consisting of five stages. Upon completing each stage, the team would be given a passcode to unlock the next one, and the team with the fastest time to reach the end wins. The tasks were designed with two principles. First of all, they needed to be stimulating and require collaborative input from all team members. For example, one challenge asked team members to identify objects in a short video given the clues, upon which each member needs to gather a similar object that carries the same meaning near them at home, and then take a group picture with these objects via Zoom [**Figure 1**]. Secondly, the tasks should also familiarize the participants with the service site, Rwanda. For example, one challenge consisted of multiple-choice where the students would need to research the social and cultural environment of the locale in order to proceed. Another task provided sounds from animals commonly found in the Safari and asked students to identify them. Each stage of the virtual stage is hosted on Google Forms that also make use of other mediums, such as YouTube and Google Earth [**Figure 2**].

Figure 1 (left). *Students found innovative ways to gather objects around them that were seen in the video to complete the challenge.*
Figure 2 (right). *One of the teambuilding challenges was hosted on Google Earth.*

B. Cultural Sensitivity Workshops

In the traditional setting, students who travel to Rwanda get to immerse themselves in the history and the culture of the country by simply being there physically and interacting with the locals. When travel is not possible, how can one put humanity back into the project to cultivate cultural sensitivity among the students? We arranged two online activities to accomplish this goal. The first is an online sharing session by individuals from various parts of Africa, and the second is a virtual museum tour of the 1994 genocide in Rwanda followed by the movie screening of *Hotel Rwanda*.

For the sharing session, we invited speakers from *The Africa Centre Hong Kong* to present the various parts of the continent they are from to dispel stereotypes. *The Africa Centre* is a platform and creative hub that fosters value-creating interactions between African and non-African communities in Hong Kong. After the Zoom presentation, students were split into groups to reflect and discuss further with our speakers on the diverse African cultures they have just learned about. Furthermore, each speaker was invited to share more intimate experiences in their life and travels in the continent for our students [**Figure 3**].

Apart from interacting with individuals from Africa online, we wanted to immerse our students deeper into the specific history of Rwanda. Taking hints from the virtual museum tours that were springing up during the pandemic, we created one of our own. More specifically, we adapted the 10 stages of genocide for the case of Rwanda [7] and hosted it on the interactive platform Gather.Town [**Figure 4**]. The aim is to familiarize the students with the difficult history of the 1994 genocide in Rwanda. After preparing the students with the facts and the background information, the virtual tour was followed by the movie screening of *Hotel Rwanda*. Afterward, the students came back together to reflect and to learn about the reconciliation efforts that went on post-genocide.

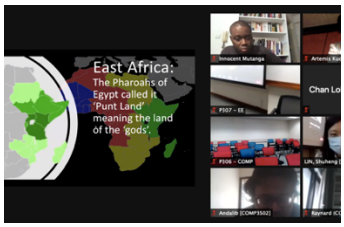

Figure 3 (left). *Sharing session with staff of The Africa Centre to familiarize students with the diverse cultures in the continent.*
Figure 4 (right). *Ten Stages of Genocide museum tour on Gather.Town. Each room has interactable objects where participants can click into and read more about.*

C. Pre-service Lab

The subjects also dedicated time to prepare students with the technical knowledge on solar energy and system. Two weeks of labs were arranged for students to install the modular system that will be sent to Rwanda. [**Figure 5**]. The entire system consists of the solar panel and its stand to be placed outside the homes, a laser-cut box that houses the controller to regulate the current flow from the solar panel into the battery, a voltmeter to indicate the voltage from the battery, and spaces for users to store their phones and radios during charging [

Figure 6]. After gaining the overall picture of the solar energy system, we invited the NGO to brief our students on the conditions of the homes they will be helping install solar systems for. The staff from the community partner also went to the field to show the training center and the homes in the villages via Zoom. Even though our students will need to rely on the Rwandan students' knowledge of the homes in the village and to communicate with the various households on where to install the light bulbs, it is still imperative that our students get an idea of the environment the local youths work in and the living quarters of the villagers before the actual service commences [**Figure 7**].

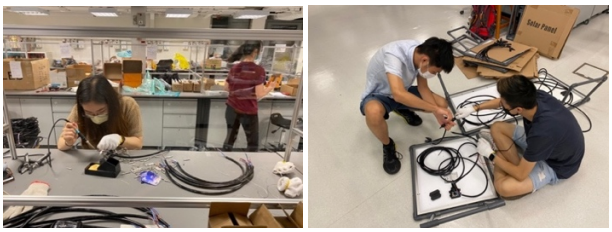

Figure 5. *Students working on soldering wires (left) and checking the connection to the solar panel (right).*

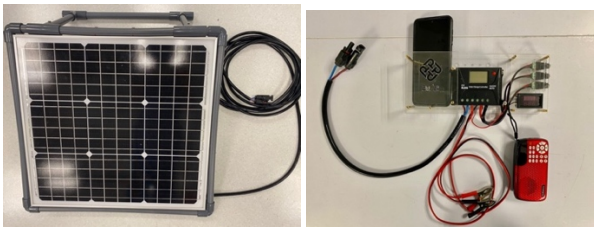

Figure 6. *Solar Panel with shelf (left) and controller box design (right).*

During the installation process of the panel shelf and the controller box in the lab, our students need to take note of the difficulties they run into so they can produce training videos for the youths in Rwanda who will be going into the villages to install the systems upon receiving the goods. In addition, before packing the 150 systems for shipping, each was tested carefully, and if problems arise our students need to figure out the origins and ways to debug [**Figure 8**].

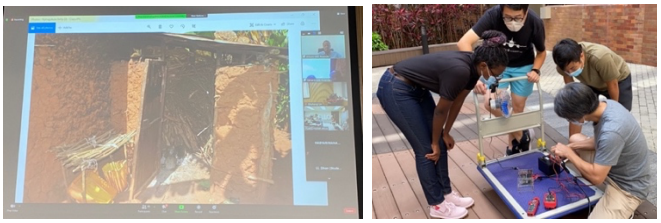

Figure 7 (left). *Community partner showing the homes in the villages in Rwanda.*
Figure 8 (right). *Testing the solar energy system under the guidance of an instructor.*

D. Online Service

[The online service is scheduled to take place during the first two weeks of August 2021, which is after the submission date of this paper.]

IV. Lessons Learned

Careful planning of the types of learning activities to be conducted online, and whether synchronously or asynchronously is imperative for maximizing student learning outcomes. Right from the start of the planning, we understand that the lab component in this course will be difficult to conduct virtually, as students need to do the actual installations so the solar energy systems can be shipped to Rwanda. However, the

academic component of the subject and related experiential activities can be facilitated online. The matter then becomes how and whether they are to be arranged synchronously or asynchronously. Since the time we have with the students was limited, lecture materials and readings were relegated to be done at students' own pace off-line, and class time was reserved for group discussions. Additional experiential activities such as team building and cultural sensitivity workshops were arranged during the weekend. In the end, the necessary knowledge and student rapport were already established before the lab session, therefore students were able to work more efficiently right from the start.

Engagement and connection can come from online interactions when the content is delivered and implemented well with the right tools. Rather than finding the perfect online platform to conduct all activities, it is better to use a mixture of tools depending on the nature of the exercise. For each learning activity, we experimented with different platforms and then chose the ones that were most appropriate for the activities. Since the virtual interface was attractive to students to begin with, they were able to stay focused through the stimulating and challenging content.

Kickstart the learning about the community early on in the process by involving the community partners. One of the key elements of a good SL experience is the ample opportunity to interact with community members as through the process students can develop the necessary civic knowledge, skills, and behaviors. When the service component is taken online, civic-mindedness can still be made relevant and tangible by involving the community partners early on in the course and allowing multiple activities to build up the relationship. This also complements students' preparation leading up to the actual service.

V. Conclusion and Future Work

This paper presents a case study of an international engineering project adapted for online teaching in the context of Service-Learning. For the SL community, our experiences and observations suggest that online SL can be more than simply migrating the lectures and/or services to a different medium. Likewise, it also does not simply involve deploying tools and practices that are commonly used in online teaching and learning to the Service-Learning space. This is especially true when online *international* SL and civic learning outcomes are involved. For the engineering and online learning communities, our experience suggests it is important that knowledge is delivered interactively and problem-based learning is promoted to engage students. With some imagination and much hard work, very tangible engineering projects can be accomplished through purely online interactions.

One of the main concerns of moving from "high-touch" to "high-tech" in a service project is that students lose the exposure that traditional face-to-face is particularly effective for cultivating a sense of cultural integration and global citizenship. Our experience so far seems to suggest that when structured appropriately, online SL can still help students achieve a similar set of intended learning outcomes with additional benefits. We hope this case study can add to the momentum of innovative development in the field of civically engaged teaching and learning, along with the evolutions we have seen in online teaching and learning.

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