Empowering Displaced Students through a Local Community-centered Engineering Education Framework

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Introduction

There are many opportunities to use engineering skills to improve living conditions in displacement [1]–[5]. However, displaced populations are often overlooked as potential engineers for their community. In a time where the global policy arena is discussing strategies to foster self-reliance by helping them to become part of the solution [6], the desire to develop solutions to displaced communities is more important than ever. On the one hand, there are many ways to use engineering education to promote self-reliance. On the other hand, there is a lack of policies and conditions to enable educators to design engineering education programs effectively in these settings. In light of these constraints, existing engineering solutions often come through international programs or external aid. This paper intends to examine a pedagogical framework, called localized engineering in displacement (LED), designed to provide displaced students with an opportunity to attend and earn credit for an undergraduate introductory engineering course within their community and foster local capacity building.

The localized engineering model used an integrated framework of active, blended, collaborative, and democratic (ABCD) pedagogies. Throughout the course, students encountered: active learning where they learned by doing [7]; flexibility to students’ needs and infrastructure limitations by using a blend of online and self-directed activities mediated by local facilitators, printed materials, and face-to-face elements [8]; collaborative learning to foster peer support, co-design, and co-construction of knowledge [9]; and democratic learning that comprised our engagement with critical pedagogy [10], [11]. Overall, the LED framework realizes social justice goals by enabling displaced populations to meet their essential needs sustainably through engineering design. This fosters social justice by creating individual and community opportunity and redirectors the authority to design and create solutions to marginalized learners. This study clarifies how engineering education, grounded in our experience in two refugees camp, can foster self-reliance in displacement by empowering displaced students. Thus, this paper investigates both engineering education and social justice in displacement and looks for places where the fields contribute to each other. In doing so, we investigate the following research question: How does localized engineering in displacement (LED) empower tertiary learners in displacement to become socially engaged?

Research background

Education is considered a critical element in the global actions responding to the refugee crisis [12]–[14], and it requires a collective engagement with multiple disciplines, stakeholders, government bodies, and non-governmental organizations. Education provides resources that are important specifically to displaced people, including psychosocial support, development of conflict resolution, and preparation for reconstruction [15]. However, education also gets disrupted in refugee situations, and displaced communities do not have guaranteed means to provide access to educational opportunities in refugee settings without humanitarian assistance [16].
In addition, within the refugee context, terms like “refugee education” and “education in emergencies” are prevalent in humanitarian reports within a context of emergency or temporary solution, which may lead to a wrong perception in terms of low quality of education in displacement. In this paper, we call attention to two aspects of refugee education taken as significant throughout this study. First, we adopted terms like “refugee education,” “education for refugees,” and “education in displacement” as terminologies referring to the educational model developed for learners in refugee camps. Second, while humanitarian reports revealed that refugees received poor-quality education in many countries [17], [18], we discuss a tertiary pedagogical model for displacement while adopting high-quality standards throughout the process to design and develop the program.

Higher education and technical and vocational training in displacement

Providing higher education to young populations can lead to durable solutions in crises [19]. Higher education is strategically important to address the refugee crisis as the opportunities for refugees are minimal and often limited by policies and opportunities. Similarly, technical and vocational training (TVET) enables economic development, social development, and reduces marginalization [12]. TVET is explored in the literature as a form of education that can be used to foster community integration [20], reduce inequalities [21], and provide workplace-relevant training [22].

On the other hand, in refugee education, both higher education and TVET face challenges. For example, young refugees are often shut out of formal pathways to learning due to refugees' lack of resources and opportunities. Of the adult refugee learners who are eligible for postsecondary education, the UNHCR estimates that only 3% are able to enroll in higher education programs [23], and the demand for higher education degrees, connected education, and vocational training have been increasing. In terms of technical training, the International Labor Office [24] points out several other challenges, such as accessing TVET programs and decent jobs, lack of information, lacking recognition of qualifications and skills, and low collaboration between employers and workers’ organizations. In light of this challenge, we developed a pedagogical model that fills in this educational gap, the Localized Engineering in Displacement (LED) model.

What is LED?

Launched in 2015, the LED was developed as a higher education response to provide high-quality undergraduate education for refugees by focusing on engineering design and community development. The localized engineering model fosters students’ agency to create solutions for themselves and co-create course directions based on students’ guidance [25]. To build on learners’ assets, the LED engineering curriculum examines the local community's boundaries and the problems they are obligated to solve. Thus, localized engineering emerged as a term to describe a pedagogical curriculum focused on advancing praxis in alignment with local standards and contextual challenges in displacement contexts, such as refugee camps. The overall goal of this course was to prepare students to solve problems using engineering design effectively. The LED course targeted the following learning objectives: 1) using a systematic problem-solving method to identify, evaluate, and scope an engineering problem; 2) applying the
engineering design process to generate ideas, critically evaluate and develop evidence-based solutions; 3) fostering the growth of reflective individuals and empower their social agency, and 4) discussing and practicing professional competencies. Students develop a capstone project where they applied the theoretical concepts learned in the course throughout the course. This capstone project is an important component of our assessment framework, where we can ensure that students are developing their technical skills and developing and practicing their social agency. Subsequently, students receive additional support to transform their ideas into real-world projects through funding or technical support.

The localized engineering model's main objective is to provide the students with an opportunity to attend an undergraduate introductory engineering course (higher education facet) and develop technical and labor-market relevant skills focused on local problems (TVET facet). The program included a LED curriculum integrating technical content, professional skills, and engineering design. The LED program's purpose was to offer a course for refugees situated between higher education and TVET and pedagogical innovation that re-centers and re-localizes displaced students. The localized engineering model seeks to associate engineering design and the knowledge uniquely held by refugee learners to develop their understanding of community needs and feasible solutions. This approach emerged from the curriculum roots in social justice through components of critical pedagogy. These components are incorporated through socially relevant problems, course co-construction with learners and local facilitators, local community engagement, and localized development and implementation.

Relationship between engineering with social justice and community development

Engineering has been recognized as a fundamental tool to transform society [26]. It can be used to foster community development by providing the capability to support people in advancing and building better places [27], [28]. Among numerous engineering education approaches for community development, engineering design consists of a systematic and informed process to support students in learning and applying engineering concepts [29], [30]. While adopting user-centered approaches [31], students see themselves as important players in conceptualizing these solutions and become social agents developing their communities. In this process, they no longer rely on international aid, and they can rethink their perceptions of development towards social justice.

The literature presents several ways to foster social justice through education. Prior researchers explored the adoption of social justice in the classroom by using collaborative and participatory models, such as a community-based participatory approach [32], [33], school-based social justice [33], and Youth Participatory Action Research [35]. Other researchers adopt pedagogical models for teaching/learning about poverty, oppression, and social justice. Education should promote liberty in terms of ideas and power to make changes in the social, political, and economic context through education [36]. Additionally, the critical role of engineering in addressing issues and challenges in humanitarian settings is widely recognized. Engineering practice enables the development of countries and communities [37]. Also, engineering has been considered a key player to plan, design, implement, and develop solutions to address humanitarian challenges [38]. For instance, the role of engineering and technology has the clear role of providing resources and conditions, such as water [39]–[41] and energy [42], [43]. In the infrastructure and management domain, engineering also plays a role in creating
solutions that address the development of livelihood conditions [44], [45], logistics [46], [47], and communication [48]–[50]. These challenges are examples of opportunities where engineering and technology play essential roles in translating ideas into an immediate solution in the humanitarian context.

**Methodology**

We conducted a qualitative case study [51] to explore the LED course development and implementation in a Kenyan and Jordanian refugee camp. This study comprised a total of 93 students, including a total of 55 students, ages 18 – 51, living in the Azraq camp from 2017 to 2019, and a total of 38 students, ages 18 – 34, living in the Kakuma camp in 2018 and 2019. The course required students to be 18 years or over, understand English, expect to spend at least 4 hours of in-class activities per course week, and attend at least 75% of the classes to receive credit. Local partners recruited potential students interested in attending the course by collecting their names and locations in the camp. The final step of the selection process consisted of a pre-course workshop. The workshop culminated in an entrance exam that included word problems in both English and Arabic that asked students to describe existing engineering challenges, basic logic and math problems, and a motivation statement.

Concerning each camp, the Azraq camp in Jordan has been a temporary home for 40,000 Syrians since 2014, and it is located in an empty desert area [52] in the province of Zarqa Governorate in central-eastern Jordan, 100 km east of Amman. The Kakuma refugee camp was established in 1992 in north-eastern Kenya, and it has grown in the population of refugees it caters to over the past two and a half decades. With a current population of over 191,500 registered refugees and asylum-seekers, including the Kalobeyei settlement recently opened in 2016 [53], both Kakuma and Kalobeyei make up one of the world’s largest refugee camps. Our data collection instruments were composed of multiple data sources, including entrance exams, semi-structured interviews, course assignments, capstone projects, online forums, instructor journals, and a field visit and report collected from each course. The data analysis had two phases. The first phase provided an in-depth evaluation of our data sources across both camps to build an overall understanding of the data. Phase two consisted of the application of thematic analysis [54] along with a variety of validation tools, such as triangulation, peer-review across research members, and member-checking with research participants. We inductively constructed themes and meaning to develop our findings, considering our research questions and removing themes that are not directly related to our research interest. The Purdue institutional review deferred approval to the University of Geneva for consent for all data collection activities, and ethical issues considered included confidentiality and voluntary participation.

**Results and Discussion**

Our analysis revealed particular aspects of the LED pedagogy that uniquely fostered social empowerment in displacement in Kakuma and Azraq. These aspects are represented below as four themes that answered our research question in this paper. Specifically, the LED course empowered students to become social agents through using local problems to frame capstone projects, centering learners as local experts, providing mechanisms to support immediate impact through entrepreneurship pathways, and engaging local facilitators as the course co-creators.
Local problems drive capstone projects

The course culminated in multiple capstone projects where students worked in groups of four to five around common interests related to local problems. Students engaged through a participatory approach with multiple stakeholders – instructors, local agencies, community, and users to understand local needs. Students also talked to members from their community, such as friends and family members. This co-design process also helped to bring political and ethical dimensions to their final proposed projects. We found that the participatory approach helped students to become more motivated and empowered to learn engineering and apply their knowledge. One interviewee, for example, said, ‘maybe you can say it is not enough, but I assure you that in a group we are able to make a miracle solution that will be never be forgotten by Kakuma.’

Figure 1. Students presenting their capstone projects in the Azraq refugee camp

Curriculum re-centers learners as local experts

The localized curriculum provided the students with a transformative experience where they were re-centered and re-localized as local experts, leading to both immediate and sustained impact focused on local development. As one student in Azraq said, ‘the course can be about to transform the mind of a student. At the end of the course, it's when your thoughts are not the same as when you finish.’ The participatory design led students to include various partners in the development of their engineering projects; however, this experience also extended their participation as end-users and local experts. Also, as local experts, students demonstrated social engagement to bring their problems to different actors. As one student in Kakuma noted, ‘this is
the only course that the students take it very seriously. The only course they came back to change in the lives of the people in the government.’

Create immediate and sustained pathways

Immediate and sustained pathways are clearest in “independent projects,” which students can pursue after graduating from the course. Both in Kakuma and Azraq, students received resources and technical support to develop their projects after finishing the course. Given the limited time during the course implementation to learn about the engineering design process, electronics, and programming, students experience a significant challenge to implement their projects after the prototype stage. Through independent projects, students have a chance to move forward with their idea with collaboration with local stakeholders. Creating pathways also helps to meet the students’ goal, which is often the desire to transform their ideas into something real and impact their community. As one student in Kakuma, for example, noted, ‘I want to see our project on Biomass Grinders working on the ground and making work earlier for individuals.’
Local facilitators actively participate in the course co-creation

We helped local facilitators, who were recruited as graduates of the prior cohort of the class, to increase their sense of ownership in the course by supporting them to become more independent when making decisions about what is best for the class or even co-constructing the course lessons to make them meaningful and locally relevant. Many of our conversations with facilitators and students suggested that their support played a fundamental role to motivate students when they struggled with technical content. Facilitators also helped to mitigate local challenges, such as lack of internet and electricity by proposing solutions. For example, they wrote down the classroom content related to a specific class on a sheet of paper during a power outage to avoid students skipping the class due to lack of electricity. Both in Kakuma and Azraq, there were a significant number of moments that reinforce the local instructors’ commitment and empowerment. For example, as one facilitator in Kakuma noted, ‘I tell the new student if you want your problems to be small get this course because this course makes your problem smaller.’ The same sense of ownership was perceived in Azraq. For example, one facilitator in Azraq noted, ‘I think we need to be flexible, if the students can go on with the same timetable, then it's good, if not then we will act accordingly.’ This quote expresses his concern with course pacing since a few students were not ready to move on to a new course topic like their peers.

![Day 3 Tutors’ training Micro-teaching](image)

Figure 4. Slide example using during the teaching certification training

**Teaching example**

- Watch the following video an experienced high school teacher engaging her students with an innovative problem and evaluating their projects in designing a trebuchet.

**Discussion and future plans**

This paper is impactful and contributes in two dimensions. First, the novelty of the LED adds to the engineering education community and education in displacement by examining effective teaching and learning in refugee settings. Specifically, this paper contributes to the application of diverse pedagogical theories and learning environments in refugee settings. We also detail the different ways in which critical pedagogy can be integrated in the course design and implementation. A second contribution relates to a different approach in terms of humanitarian engineering. The unique contribution of this paper highlights the value of value local expertise by re-centering the role of learners, facilitators, and local community. Via this paper, we propose another approach to foster participatory teaching in humanitarian settings, where we increase the engagement and co-creation of initiatives in displaced communities along with local communities.

Our results reveal a multifaceted approach to foster social agency through a pedagogy model. Basically, our experience in Kenya and Jordan revealed the need to propose sustained and
long-term programs that generate and promote local impact, and outcomes stay in the local community. However, there is a gap between international goals to provide long-term conditions to displaced learners and the reality on the ground. We also identified a need engage with local community throughout the whole process of course design and implementation. In other words, education researchers should be cognizant of strategies to co-create their courses with local community, where they can participate in strategic decisions or even receive professional training to take ownership of the initiatives in long-term.

In light of our research question, this study revealed four key aspects of the LED program that support tertiary learners in displacement to become socially engaged. First, capstones projects are driven by local problems identified by the students themselves using engineering design process. Second, the entire curriculum and pedagogy is designed to empower learners and facilitators by recognizing them as local experts. Consequently, they participate in decisions related to course assessment, content, and pedagogy. Third, we provide immediate pathways to students work on their projects after finishing the course. In other words, students receive technical and financial support to develop their capstone projects and ideas emerged in the course. Fourth, we also provide teaching capacity to local facilitators so that they actively participate in the course development.

In the future, we will continue developing and refining the pedagogical model based on research findings of how to implement and integrate active, blended, collaborative, and democratic learning environment. The next research steps will be to continue exploring the localized engineering model in other displaced contexts. More specifically, it will be useful to develop a better understanding of engineering design, community development, and entrepreneurship pathways, as well as their connections to each other. It will also be important to develop measures for psychosocial support and community agency through engineering. Finally, the results of my comparative case study suggest several opportunities for future research in education in displacement. For example, further study can investigate the relationship between student experiences with culture, demographics, gender, and age. In addition, future studies should consider the socioeconomic and political barriers on each camp beyond the course period to get a holistic view of the alignment between the engineering curriculum and different realities.

Conclusion

While there is much research about engineering education and social justice, there is still a gap to understand the challenges and opportunities to understand how engineering curricular can promote social justice in displacement. In this study, we identified four themes that unpack to what extent the LED framework helps to fill out this research gap. First, we offer a unique opportunity to understand participatory design in displacement. Second, we propose a model to re-center displaced learners as part of the solution in displacement. Third, we describe an alternative pathway where students have an opportunity to develop their ideas and transform their projects into real-world products. Fourth, we propose a pedagogy where local facilitators help to co-construct and co-implement the course so that they feel a sense of ownership and commitment with course success.
Specifically, it is important to engage policymakers and local stakeholders on future initiatives in order to enable policies that allow students to effectively find resources and materials needed to implement their ideas in long-term. Overall, we found that our localized engineering approach helps to foster social justice in displacement by providing a sustainable pathway where displaced learners are empowered within the classroom to understand their needs within their community. Then, learners can use their engineering skills to address these needs through a participatory approach.

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