Fostering Engineering Thinking in a Democratic Learning Space: A Classroom Application Pilot Study in the Azraq Refugee Camp, Jordan

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Abstract

In recent years, there has been a call for education initiatives targeted to refugee camps. In 2017, Purdue University and the University of Geneva implemented an engineering course that responded to these concerns by empowering learners to not only address challenges in their communities but also develop engineering thinking. The pedagogical core of this course was grounded in the principles of a democratic learning space. The purpose of this work-in-progress is to describe our approach and illustrate artifacts from the pilot course. In doing so, we address three key objectives:

1. What aspects of the introductory engineering course (intended outcomes, assessments, and activities) were contextually aligned to opportunities and constraints in the Azraq refugee camp?
2. How did the introductory engineering course foster students’ social responsibility to the local community of Azraq?
3. In what ways can the final course outcomes be aligned with social responsibility?

Azraq hosts the second largest camp community of refugees in Jordan, representing a total of 53,833 people of concern originally from Syria. As the conflict in Syria has continued, the size of the Syrian population forced into refugee conditions has increased. The United Nations called for immediate action to assist people in Syria, considering the fact that over half the country’s population have fled their homes, and 4.8 million people are refugees in the region and beyond [1]. Given this ongoing crisis, we designed the course to enable learners to learn technical engineering skills and provide access to higher education by awarding academic credits at the end of the program. We used a combination of remote and local staff as facilitators in addition to technology tools for online and active learning. The overall structure of our course is set up as an active, blended, collaborative, and democratic learning space.

In light of the unique educational context, we describe in this paper our course design process, and then we explore student artifacts, interviews, observations, and surveys to answer our three objectives. In doing so, we believe this research and application example can contribute to the literature by understanding an implemented course structure and the development of students’ technical and non-technical skills, sense of community, social responsibility, and sense of independence in refugee settings.

This paper is structured as follows. First, we present the overall motivation prior literature about educational initiatives addressed to refugee contexts. Next, we describe our course context and teaching and learning strategies we adopted. We then address our research objectives by linking each research goal to our findings regarding content, assessment, and pedagogy. Finally, we present our discussion and future work related to future courses and implications from this pilot study.
Introduction

The education of Syrian refugees faces significant obstacles to access at the post-secondary level [2]. Indeed, displacement for extended periods of time has been shown to result in more difficulty accessing tertiary education opportunities [3]. A recent report from UNESCO estimates that 26 percent of Syria’s population was enrolled at the tertiary level before displacement, but many had to interrupt their studies due to the crisis [4]. This unique challenge motivated our engineering course in offering university-level credit for students at the tertiary level in the Azraq refugee camp in northeastern Jordan.

The reason for selecting refugee camps as a population in our research is the emergent crisis that has spread nearly exponentially over the last two decades to multiple affected regions across the world [5]. This challenge is multifaceted, and it requires more attention from individuals and organizations to minimize the effects of fragile and conflict settings on people’s lives [6]. We believe that education is a powerful tool to foster hope and mitigate disruption to educational and career pathways for students living in refugee camps. However, more than improving professional skills, instructors need to empower students to become agents of change in their communities. In other words, education should support the development of students’ skills and promote their understanding of relevant problems in their community by fostering and supporting more participatory, empowered, and engaged students [7]. By combining this mindset with engineering thinking, our course goals were intended to provide a short but transformative life experience that empowered and fosters students’ growth as holistic engineers. We define each of these concepts further below.

Throughout the course, students gained professional and technical skills, which allowed them to be hired by local authorities in the camp to apply their knowledge and gain professional experience towards future professional opportunities. Also, students had the opportunity to get academic credits that could be used later on in formal higher education. This social empowerment played an important role in selecting critical pedagogy (CP) as a theoretical framework to ground this study. We believe that critical pedagogy is an appropriate framework for our class application and research because this framework centers students as engines that alter their own social and economic dynamics, which aligns with the course goals and activities in our class [8]. Since critical pedagogy is a broad concept and field of study, we focused on two critical features in our first class: (1) establishing a sense of equity by setting a democratic learning space (DLS) in the classroom and (2) supporting students as agents of change in their community through engineering thinking.

We explored the literature to identify examples and lessons learned from existing studies in conflict zones and refugee camps to inform our work. These studies recommended the integration of tools [9], the use of transformative language-learning [10], and the adoption of CP through humanistic lenses [11] as a means of contributing to the development and well-being of learners in these contexts [12]. Throughout this paper, we describe our experience building from prior work and applying CP elements in the curriculum. We also describe student and course outcomes as a result of our integration of CP elements.
As this is a classroom application study, we have broad objectives (not empirical research questions) that we address in this paper. The first objective is: (1) What aspects of the introductory engineering course (intended outcomes, assessments, and activities) were contextually aligned to opportunities and constraints in the Azraq refugee camp? The two remaining objectives are grounded in critical pedagogy theory and its relationship to the engineering learning process. These two sub-research objectives are: (2) How did the introductory engineering course foster students’ social responsibility to the local community of the Azraq camp? and (3) To what extent can the final course outcomes be aligned with social responsibility?

**Literature Review**

According to the 1951 Refugee Convention [13], refugees are among the most vulnerable people in the world. The 1951 Convention is a key legal document that endorses a single definition of the term “refugee.” A refugee, according to the convention, is “someone who is unable or unwilling to return to their country of origin owing to a well-founded fear of being persecuted for reasons of race, religion, nationality, membership of a particular social group, or political opinion” (p.3) [13]. In the last two decades, war and persecution have driven people from their homes at an alarming rate. The most recent report created in 2015 by UNHCR [14] described an unprecedented 65.3 million people around the world forced from their homes. Among them, 44 million people were forced to flee but were within the confines of their countries (internally displaced people), and 21.3 million people were considered refugees. In a world where nearly 34,000 people are forcibly displaced every day, initiatives to improve their living conditions are more important than ever before.

Many efforts intend to offer resources and promote activities in order to establish a community or social unit in refugee settings. In this paper, the local community can be defined as a group of people, who can go to a common center with organized services, such as stores, schools, churches, libraries, and medical and legal institutions [15]. Refugees face multiple obstacles to continuing their education or acquiring professional qualifications. A consultation with refugee groups organized by UNHCR [16] revealed that several factors contribute to the educational access and persistence problems, such as the economic situation, distance of the school, lack of transportation, low engagement, and lack of subsequent opportunities [16]. This emergent crisis is visible across education levels but is perhaps most acutely felt in higher education. UNHCR estimates that, globally, despite big investments in scholarships and educational programs, the percentage of students enrolled in higher education remains stuck at 1 percent [17].

Higher education is a human right grounded in the Universal Declaration of Human Rights (Art. 26.2) that should be guaranteed and served as an incentive for students to complete their primary and secondary studies. Unfortunately, this human right is often violated in conflict and crisis zones. In these zones, students experience distinct conditions of displacement, fragility, and upheaval that impede their access to formal educational programs. Thus, it is important to create opportunities for continued education at the post-secondary level [9] in fragile contexts. The students in our class were refugees forced to flee their homes from
persecution in Syria, and we hope this work will inform good practices in designing engineering courses aligned with social empowerment in fragile contexts.

In this study, *fragile context* refers to a set of conditions that influence the access and quality of education for students at different levels of schooling. These conditions can be represented by places affected by poverty where inequality, violence, and injustice play an important role in the student’s experience within and outside of the classroom. Some contexts where humanitarian settings are sensitive to social, political, and economic problems include *favelas* [18], isolated schools in urban areas [19], refugee camps [13], and conflict and crisis zones [20]. In this study, we focus on the refugee camp setting as a fragile context.

**Access and Educational Needs in Refugee Settings**

Access to education represents a significant obstacle in refugee contexts, and many causes are potential barriers to education, such as space shortages, language and curriculum, transportation, parental documentation, child labor, early marriage, school fees, and safety [2]. Given these barriers to access, Culbertson and Constant [2] suggested, “[T]here is a need to alleviate the situation with innovative educational strategies to coordinate efforts, share knowledge, make evidence-based decisions, improve efficiency or effectiveness, and solicit resources” (p. 2). Although some of the findings cited here are contributions from research in primary and secondary education, these challenges remain applicable to tertiary education.

The refugees’ educational needs are different from non-refugee learners, as their experiences entail different psychosocial challenges that add a layer of complexity for instructors who are teaching the course but are unfamiliar with daily life in refugee camps [21]. This course intends to minimize such challenges by utilizing a democratic learning space (DLS) and distance learning tools to adapt and respond to learners’ needs [22]. This DLS can be implemented by providing access to those who were otherwise excluded from formal tertiary classrooms in general and from student-centered engineering classes specifically [23]. Therefore, distance learning in a DLS can help to carry students’ voices who otherwise would not participate [24].

It is not surprising that students participating in online learning environments valued their networking and social interactions the most [25]. However, the instructors’ role in these courses has shifted from that of the lecturer to a knowledge facilitator [26]. There are needs that instructors must meet when implementing courses using distance education tools. For instance, instructional design can be mediated by cultural and social barriers related to the content and structure of the course to be transformed to a distance learning platform [27][28]. Instructors and course designers should have a keen eye for navigating and to responding to cultural differences [28]. Thus, significant skills and commitment are required from teachers and facilitators to have a successful distance education course [29].

**Course and Summary Description**

We provide more detail about our course structure first so that we can then discuss its alignment with the constraints of the context and our application of CP. By describing our classroom application, we want to emphasize both our challenges and findings in teaching
engineering within a DLS in a refugee setting [30]. The learning environment was designed as an active, blended, and collaborative learning environment, which is supported by the literature as an effective environment to teach university-level engineering [31]. Given the context of the classroom in the camp, as well as the challenge of teaching engineering in a politically complicated and highly regulated environment, we followed a course methodology based on recent studies about education in fragile contexts and previous experience from the researchers in teaching engineering [32] [33] [34]. Also, we designed our intended outcomes, content, assessment, and pedagogy with the goal of fostering social responsibility so that the course would be meaningful and applicable to students’ local community. For example, we considered existing engineering problems in the community and pedagogical constraints in the classroom as part of our course planning based on democratic basis.

Democratic learning spaces, a concept grounded in critical pedagogy, have been used to support social responsibility in the classroom. In this course, our concept of DLS is grounded in three key elements as defined by Ade-Ojo and Duckworth [30]: acknowledgement and provision of an element of agency for the learners; the nature and content of the curriculum, to which the learners must have a significant input, including the objectives of their learning; and the pedagogy through which learning is delivered. In fact, numerous authors have been exploring this democratic approach as applied within existing classrooms, but there is a lack of literature describing such a learning environment in fragile contexts. For example, Murphy [35] discusses DLS through open spaces for dialogue and inquiry. In doing so, he intended to promote independent thinking in the classroom and fostering a sense of active citizenship capacities. In fact, this is one of the goals in our course, but the refugee setting includes a significant number of additional constraints. Merrifield [36] emphasized the civic participation of adult learners. According to him, education should empower adult learners to change society, and education needs to provide the knowledge and skills necessary to promote change. In this course, we consider those social elements as part of our democratic space so that we seek to empower students, not only as engineering students but as agents of change in their local community.

The Azraq Refugee Camp

The Azraq camp opened in April 2014 in order to accommodate Syrian refugees. Currently, Azraq camp is operated jointly by UNHCR and the Jordanian police, and several international organizational partners provide support through funding, professional courses, activities, and other initiatives. The population in the camp has continued to increase, and the most recent report [37] indicates an equal gender distribution in the camp among men (49.4%) and women (50.6%). The overall structure in the camp is represented by local Jordanian management which works with UNHCR coordination. Both sectors are in charge of managing basic needs in the camp regarding education, shelter, health and nutrition, livelihoods, protection, and security. In this course, UNHCR played a role in facilitating some of the logistic connections between the instructors and local staff. In formal education, the Azraq camp runs primary and secondary schools as part of the strategy to guarantee access to education for all children in the camp. These schools operate in two different settings for girls and boys separately. In our course, we are working at the tertiary education level, where a space was created to accommodate male and female learners in the same course.
Course Learning Objectives

The classroom structure was broken into three different elements often used in course planning: content, assessment, and pedagogy. We started by setting course- and class-session learning objectives to align all parts of our course planning. This strategy is also known as the backward design [38]. This strategy is a challenging process in refugee settings given the number of unpredictable factors that might affect course planning, including existing constraints due to extensive regulations. In the next sections, we briefly discuss the elements of our course design that were intended to align with constraints and opportunities in the camp and theoretical basis.

In fact, designing a course for Azraq demanded a good understanding of the existing constraints before planning learning objectives, assessments, and pedagogy. On the other hand, we did not have access to all of the constraints in advance. With this in mind, our team navigated through multiple stages starting from course conception until the final design review presentation. Each stage will be described in this paper in order to illustrate and clarify our challenges, constraints, outcomes, and lessons learned. In Figure 1, we illustrate the timeline we followed.

![Course Timeline](image)

**Figure 1. Course stages**

Since this is a work-in-progress paper, we will focus on the development process of this course and the experience of implementing it. Our course objectives can be described by the following enduring outcomes: (1) understanding engineering as an approach to solving real-world problems; (2) learning professional skills and applying these skills to local development challenges; (3) empowering learners to become agents of change within their community; and (4) facilitating access to higher education experiences for refugee learners.

Recruitment

The course took place in a shared space where other events and classes occurred at different times. We planned the course to be three months long, by having two sessions per week each one lasting 2 hours. Originally, the course was created to support 15 tertiary students aged from 18 years old and up. Given the massive interest in taking this course, we increased the number of students to 29. The engineering course was designed to support a classroom within the following requisites: learners must be 18 years or over, understand English (with additional materials in other languages), attend an introductory course workshop, complete interviews, and course surveys, work in a team-based environment, and have curiosity about learning and applying what they learned to support their community. All these requisites were explained in the recruitment process.

The recruitment process was structured based on an internal callout within Azraq through flyers disseminated by local staff and an entrance exam. There was no fee associated with course
enrollment, and all students were required to take the entrance exam on the same day and hour. The entrance exam was performed one week prior to the first-course day. Learners were selected via the 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. By using rubrics as a template for our analysis, we evaluated not only technical knowledge but also their motivation to take the course. On the other hand, selecting students in this fragile setting also require flexibility in the final number of students.

Given the prior experience with courses in a similar context, we selected an additional number of students by predicting a significant number of students dropping the course throughout its span, due to various reasons beyond our control, such as time conflict and health issues. Additionally, we prioritized their motivation in taking the course beyond all other technical aspects in the entrance exam. The 29 students initially selected included 19 males and 10 females. While at least four male students disclosed having STEM-related experience, none of the female students had disclosed having such prior exposure.

Kickoff Workshop

In the workshop, we provided an overview of the entire course where students could get a sense of what they would learn in the course for three days. In doing so, we expected to increase their excitement about taking the course. Additionally, this workshop provided an opportunity to get familiar and build social connections with the students, local facilitators, and the local structure in the classroom. By knowing that, we could perform modifications and improvements at the beginning of the course to adjust our initial planning for the reality of the course and student needs.

During the workshop, we planned the following goals: (a) getting familiar with local facilitators, managers, and infrastructure; (b) introducing the main ideas and motivating students; (c) establishing a face-to-face connection with all students; (d) providing technical training about electronic tools used in the technology; and (e) establishing guidelines and internal policies with students to be followed throughout the course. The effectiveness of this workshop can be seen in the sentiment expressed by one of the students in a post-course interview: “The most entertaining part of the course and we learned the most of is the first week [The Kickoff Workshop]. This was due to the presence of those in charge of the educational process and their closeness to the students.” In this interview and other preliminary data we gathered, we see that the goals we set out to accomplish were met, serving as a testimony to the efficacy of the kickoff workshop.
Figure 2. Students discussing and creating electronic circuits during the kickoff workshop

In the next sections, we address each of our three objectives outlined for this classroom application. To meet each objective, we highlight the strategies we used to maximize opportunities and learning experiences as well as challenges faced and important considerations for future applications in similar contexts.

**Objective 1: What aspects of the introductory engineering course (intended outcomes, assessments, and activities) were contextually aligned to opportunities and constraints in the Azraq refugee camp?**

**Intended Outcomes and Content**

Given our goal of aligning our learning objectives to the needs, opportunities, and constraints in this fragile context, selecting the most relevant topics to be explored in the course was a challenging process. We identified solar energy and the related electrical engineering and electronics as a relevant, though broad, problem space within which we would concentrate our first introductory course challenge. The course tutor had relevant sub-disciplinary experience in the industry and applied his experiences to further developing course content. The engineering design process as a framing device for the whole course was built off of existing classes administered at Purdue University and using methods supported by the literature [31]. Thus, we organized the course structure in order to challenge students to learn relevant technical skills and knowledge, as well as the engineering design process.

In order to clarify how this course was organized, we present in the following picture a roadmap where all modules are organized chronologically. Every module was planned according to the course development, learning objectives, and timeline we needed to follow to fully complete the course.

![Course Roadmap](image)

Figure 3. Course Roadmap

We were very parsimonious with the course content due to the limited course duration, but students were given the opportunity of additional support from a team of tutors, instructors, and supplemental materials outside of regular class time in case they wanted to explore additional topics beyond what was taught in the classroom. As students proceeded through the design process with their specific products, they were advised by the course team on additional technical questions and more advanced applications most relevant to their group’s particular
issues. In this way, the content was further tailored to students’ interests and the problems they identified in the camp. In addition to that, time availability also played an important role on course length.

We planned the course to last for three months. However, local constraints in terms of facilitators’ and students’ availability each week, limited resources such as internet and electricity, and holidays had a significant influence on the course planning by causing the course duration to increase to 5 months. Because of the democratic nature of the course, student groups and local stakeholders were involved in changes throughout the course, and their feedback guided many of the choices made. It is crucial to establish those changes when all parties are involved, such as stakeholders, instructors, facilitators, and learners, to maintain a balance between the needs of the different groups involved in the running of the course.

Assessment

The assessment framework relied upon strategies to measure and evaluate student’s understanding. However, to do so, we had to assure our content was meaningfully constructed and connected to all classes, activities, and assignments. Given the lack of time to work on homework or final projects after class, the course was designed to assess as much as possible during class time. Additionally, we had to include our assessments strategically throughout the course through rubrics and check-your-understanding questions in the online platform. Overall, we had to take several decisions in order to assess students efficiently as presented in the next paragraphs.

First, we decided not to include homework or exams in the course. Therefore, we used our time in class to walk through content and minimize the workload after class, given the students’ lack of access to internet and class content outside of the classroom. A second decision was creating a final project that should be developed in different phases. This final project was a practical application of engineering design process addressed to their local problems. Third, we used short, ungraded questions after each module for every class as one method to measure the understanding of students regarding a specific module. Although our assessment strategies were grounded in the literature, the nature of our classroom required a responsive assessment guided by student reactions and performance throughout the course. For example, assigning individual activities had a significant impact on the class progress. Therefore, we primarily included team-based activities to all classes in order to foster collaboration and facilitate individual assessment by pointing a team leader to each team in order to report the progress of their team members rather than contacting and assessing each student individually.

At the end of the course, students presented their final project. In this presentation, we evaluated their performance through a specific rubric designed to capture and evaluate their overall performance in meeting learning goals and objectives. These presentations were evaluated by a variety of stakeholders, including the instructors themselves, local personnel, and even a practicing engineer in the camp. The learning goals assessed on the final project addressed evidence-based decision making, engineering ethics, idea fluency, professional communication, problem scoping and solution quality. A complete representation of the final rubric is presented below.
<table>
<thead>
<tr>
<th>Learning goals</th>
<th>Learning Objectives</th>
<th>Not submitted (0)</th>
<th>Needs improvement (1)</th>
<th>Satisfactory (2)</th>
<th>Excellent (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Evidence-Based Decision Making</strong> (EB)</td>
<td>Use evidence to develop and optimize solution. Evaluate solutions, test and optimize chosen solution based on evidence.</td>
<td>Test prototypes and analyze results to inform comparison of alternative solutions. (EB1)</td>
<td>Team did not test the prototype or did not present evidence about the comparison with alternative solutions.</td>
<td>Team performed a limited number of tests. Results are limited and/or inaccurate. The results are not used to meaningfully compare alternative solutions.</td>
<td>Tests and results present reasonable information, but the comparison to alternative solutions does not clearly utilize test information.</td>
</tr>
<tr>
<td><strong>Engineering Ethics</strong> (EE)</td>
<td>Recognize how contemporary issues as part of cultural, economic and environmental factors impact engineering design and practice.</td>
<td>Identify assumptions made in cases when there are barriers to accessing information. (EB2)</td>
<td>No assumptions acknowledged.</td>
<td>Team used inaccurate assumptions.</td>
<td>Team presented relevant assumptions about their project, but did not provide concrete evidence and references of information sources.</td>
</tr>
<tr>
<td><strong>Idea Fluency</strong> (IF)</td>
<td>Generate ideas fluently. Take risks when necessary.</td>
<td>Articulate reasons for answers with explicit reference to data to justify decisions or to evaluate alternative solutions. (EB2)</td>
<td>The team did not show any correlation between data collected and their decisions.</td>
<td>The team presented limited or irrelevant data, which are unconnected to their evaluation of alternative solutions.</td>
<td>The team established a correlation between data and evaluation of solutions, though some connections may be unclear.</td>
</tr>
<tr>
<td><strong>Professional Communication</strong> (PC)</td>
<td>Use professional communication (written, visual, and oral), free of</td>
<td>Justify decision-based on cultural, economic, environmental and other applicable factors recognizing how engineering practice is not only based on technical information but is shaped by cultural, economic, environmental and other factors. (EE1)</td>
<td>The team did not consider the impact of their project regarding cultural, economic, environmental and other factors influenced by engineering practices.</td>
<td>Team listed limited broader impacts from their concept and had difficulty explaining these impacts. They did not make a connection with contemporary issues impacted by engineering practices.</td>
<td>The team considered some cultural, economic, environmental, or other factors. Connection to their decision making may be inferred, but is not explicit or is lacking concrete information.</td>
</tr>
<tr>
<td><strong>Professional Communication</strong> (PC)</td>
<td>Use professional communication (written, visual, and oral), free of</td>
<td>Generate a wide range of solutions including ideas not readily obvious or combinations of ideas in new ways. (IF1)</td>
<td>The team presented only one idea.</td>
<td>The team presented a limited number of ideas, but more than one, and did not illustrate how they are different from each other.</td>
<td>The team presented a wide range of ideas, but it is unclear how the ideas are differentiated or how they would be evaluated.</td>
</tr>
<tr>
<td><strong>Professional Communication</strong> (PC)</td>
<td>Use professional communication (written, visual, and oral), free of</td>
<td>Support all claims made with evidence that is either generated or found. (IL2)</td>
<td>The team did not use evidence to support their claims.</td>
<td>The team used limited evidence to support their claims, which might have been unincited and inaccurate.</td>
<td>The team used some relevant, concrete evidence from credible sources, but may have had trouble connecting to their claims.</td>
</tr>
<tr>
<td><strong>Professional Communication</strong> (PC)</td>
<td>Use professional communication (written, visual, and oral), free of</td>
<td>Components of professional communication to present</td>
<td>Team demonstrated a low level of professional communication to present</td>
<td>Team presented a good level of communication skills to illustrate their ideas. They</td>
<td>Team has a good level of professional communication. Presentation was easy to</td>
</tr>
</tbody>
</table>

Table 1 – Rubric template used in the final presentation.
<table>
<thead>
<tr>
<th>Problem Scoping (PS)</th>
<th>Solution Quality (SQ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Develop a problem statement from the perspective of stakeholders. Refine the problem statement as additional information is found through the process of design.</td>
<td>Design final solution to be of High technical quality. Design the final solution to meet client needs, moreover, the user needs.</td>
</tr>
<tr>
<td>Explain the problem based on synthesis of client, user, and other stakeholder needs. (PS1)</td>
<td>Document all contributions to the team performance with evidence that these contributions are significant. (SQ3)</td>
</tr>
<tr>
<td>Justify why problem is important to solve by referring to relevant global, societal, economic, or environmental issues. (PS2)</td>
<td></td>
</tr>
</tbody>
</table>
Activities

The main pedagogical framework in this course relies upon active, blended, and collaborative (ABC) learning. This framework has demonstrated effective results in other engineering courses [31], and we found this framework appropriate to be used in the Azraq camp. The ABC learning environment can be described as a course grounded on three main educational elements: (1) active learning where students learn things by doing, (2) blended learning where students can use online resource to support traditional learning in the classroom, and (3) collaborative learning where students work in teams throughout the course while they do activities and projects together.

Several factors influenced our decision in selecting ABC learning as our main pedagogical framework for this course. For example, given the distance nature of this course, we decided to create a blended course by combining an online platform, where students interacted with course content, with traditional activities in the classroom managed by a local facilitator. Since it was a distance course, we included one local facilitator in order to help facilitate each class by preparing for all classes in advance and coordinating the course progress on the ground. Therefore, we verified that a blended framework would be appropriate for this content. The active learning piece is a consequence of the engineering nature of this course. Students should be able to apply theory learned in the course in real projects by using electronic tools and programming in order to turn their projects into real prototypes. Finally, the collaborative piece in this pedagogical framework relies on the importance of establishing a collaborative environment where our course could foster a sense of collaboration and community in the classroom whose definition is also part of our learning objectives.

Further, our course focused on promoting a sense of equity and participation (DLS), both grounded in critical pedagogy. We considered the existing challenges while implementing these concepts and aligned our teaching and learning activities. These CP concepts were integrated through the use of the engineering design process in terms of selecting socially relevant problems and by incorporating specific activities in the class intended to promote a DLS. For example, students could participate actively in classroom decisions and modify their experience as students in the classroom to improve their learning experience.

Even though we planned our pedagogy to maximize learning opportunities in the course, we still experienced constraints that required intervention from our research team in order to meet our expected outcomes. Time constraints were presented as one of the most crucial constraints because a number of pedagogical decisions were taken by considering the minimum time available to implement our pedagogical strategies. Even though we planned our course to overcome limited time, we still faced challenges that required changes in the amount of content and activities planned for a specific class. Given these troubles, we had to implement responsive planning in order to meet the learner needs as well as our learning objectives. Consequently, the course period was drastically extended. Otherwise, we would not have been able to achieve our learning goals. Further, the lack of infrastructure such as consistent access to electricity, computers, internet, and electronic tools was also a significant limitation. Not all students had access to computers or internet in their shelters, resulting in us creating an alternative
communication channel to converse with students and providing alternative ways for submitting their assignments.

**Objective 2: How did the introductory engineering course foster students’ social responsibility in the local community of the Azraq camp?**

Throughout the course, we integrated elements of social justice and CP through different avenues as part of our goal to establish a DLS. First, we promoted a sense of equity starting from the recruitment process until the final presentation. This sense of equity was reflected in our approach to reaching out to each student individually without demonstrating privileges to a specific group of students. We also created a learning environment where tutors and students could talk to each other easily throughout the course. This open line of communication seemed to have a strong relationship to the sense of community and collaboration within the classroom. Second, students were able to take decisions in some assignments. Decisions regarding creating teams, agreeing on due dates, scoping project targets, and presenting their project all involved input from students. By doing so, we tried to promote a sense of independence for students.

This sense of independence was also fostered by classroom planning. In other words, we minimized the role of the facilitators in the classroom by contacting student group leaders directly with classroom instructions. Such a dynamic influenced the relationship between instructors and students by increasing the confidence and accountability between each other. This change was made approximately halfway through the course in response to student requests. Early in the course, we saw that many students were driven by what seemed to be a competitive attitude between and within teams. However, as the course progressed, we noticed that students started to develop a sense of collaboration in the course by supporting each other’s successes. This change was even more notable after we connected more closely and directly with student group leaders instead of the local NGO facilitator. This classroom dynamic also represented elements of a cooperative community, where they switched from a competitive mindset towards a more collaborative way of thinking.

**Objective 3: To what extent can the final course outcomes be aligned with social responsibility?**

One key element in this introductory engineering course is the design solution addressed to a local problem. Students applied their knowledge towards local challenges by using the engineering design process and real-world prototypes. This project is used as part of the main assignment where students created a final project through an iterative process. However, they also had to demonstrate how their project had a social impact. As an outcome of this course, students created three different projects aligned to the course goals and identified needs in the camp. The three projects were scoped under problems that require technical solutions: (1) a smart truck used to collect trash in the camp by using sensors to monitor its physical position and trash level, (2) a smart house controlled and monitored by gas, flame, and light sensors, and (3) a greenhouse powered by solar cells used to save electricity. At the end of the course, each team presented the result of their project through a final presentation to local judges, stakeholders, and the public.
In the final presentation, students had an opportunity to demonstrate all steps involved in the development process as well as demonstrate skills they learned as a result of being in the course. During this final presentation, we had the opportunity to judge their performance through a set of elements in the rubrics, and then provide feedback properly at the end of the presentation.

![Students' preparation to communicate their final project](image)

**Figure 4. Students’ preparation to communicate their final project**

In the final presentation, we assessed students’ sense of social responsibility as demonstrated in their projects. For example, one of the groups used the following statement to introduce themselves: “A group of young people living in Azraq Camp. We were one of the lucky people who took a course with Purdue University (Introduction to Engineering). We are now taking our first steps to advance the society which we live Through our project 3S Azraq.” In just their introductory statement, we see that students expressed a sense of their social agency through engineering. This attitude was reflected in other group oral presentations and the slides they created to describe their work.

**Summary and Future Work**

We described in this paper our lived experience of a classroom application in a refugee camp. Although the fragile nature of the classroom includes multiple constraints, we believe that our approach has addressed some of these constraints. Among several findings, we would like to highlight some of the most important elements in this class that significantly impacted our course planning and expectations.

First, we found that although students live in fragile conditions, they still demonstrated a high level of interest, enthusiasm, and commitment to the course and motivation to accomplish all assignments. In fact, none of the students who dropped the course cited the challenging content as the reason for not continuing. All students that dropped the course left for external reasons related to family issues, jobs, or time conflict with the course. We found that gender was a huge mediator of the external conflicts that caused students to drop out. While a large number
of both men and women left, conflicts were felt more acutely for women, and a much higher proportion of women dropped the course. By the end of the class, all of the women had dropped out because of family/health issues and time conflicts.

Second, despite our best intention to be flexible in due dates and types of assignments, even under agreements with students, students complained about extending our due dates and the course length after a few months. Originally, we planned our course to be three months long. However, due to external factors, holidays, internal policies, and time conflicts, we extended the course for additional three months. Another finding is related to the sense of collaboration created among students. We designed this course by minimizing competitive aspects of the assignments and fostering a collaborative environment. We noticed that at the beginning of the course, students still demonstrated a competitive attitude as observed through informal conversation with students and groups. As the course went on, we perceived a more collaborative environment, where students showed cooperative behavior. Such behavior was demonstrated in their weekly surveys and post-course interviews.

Third, we also want to highlight the role of the local facilitator in the course progress and students’ motivation. In this course, the facilitator expedites the communication between instructors and students, as well as local partners. Additionally, they provide local support in terms of opening the classroom, managing time, and tracking student attendance. Throughout the course, we verified that minimizing the dependence on the facilitators and increasing student responsibilities is a positive influence on student performance. Thus, we decided to give more independence to students by sharing the class planning with them, instead of making facilitators intermediaries. Overall, we saw that this modification yielded significant improvements in students’ engagement and fostering of a DLS.

Although many factors modified our original plans, we received very positive feedback from students at the end of the course. In post-course interviews, students gave insights into their experience taking the course. Student 1 said, “I am proud of being a student in this course, the course was great. I work in the solar power sector, and this course showed me more about it. This was my first introductory course through a distance which was amazing. I learned to develop my English skills, and I learned how to do programming with the Arduino. The most important part of the course that I learned was solving the problems”. Students also shared feedback about the course structure and the collaborative environment. For example, student 2 said, “It was a great learning experience where I learned how to learn in a distance learning environment and learn additional experience within the engineering field and develop new friendships. Learning with them was a great and enjoyable experience.”

Based on post-interviews, we verified that students wanted to pursue a second version of the course with more advanced content. This course provided a unique opportunity for students to develop professional skills, the ability to utilize engineering thinking and obtain credits from an institution of higher education that can later be used to validate their skills as engineering students. We hope that the challenges and lessons learned that we shared in this paper will help other instructional teams in similar contexts to serve better students given constraints as a consequence of fragile contexts.
Given the successful approach in this pilot study, a second course is being implemented, taking into consideration lessons learned from the pilot project. In the second course, we use a similar approach informed by backward design and socially relevant problems embedded into the curriculum, assessment, and pedagogy. Although we experienced many challenges during this first pilot, we believe that our course moved towards meeting tertiary students’ real needs in a refugee camp. Our practical approach of combining engineering with real-world projects applied to local problems allowed students to become interested and to see tangible opportunities as agents of change in their communities.

Reference


