Integrating an *engineering justice* approach in an undergraduate engineering mechanics course

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***Abstract*— This research-to-practice WIP paper describes the design and creation of instructional materials grounded in the engineering justice approach, as described by Leydens and Lucena, in a 16-week engineering mechanics course – *statics and dynamics*. The instructional materials were designed as two successive 8-week long, project-based learning (PBL) units centered around fictitious scenarios in real-world settings. The first PBL unit focused on a *truss bridge project* with deliverables structured around the human-centered design (HCD) process, and the second PBL unit focused on an *amusement park project* with deliverables structured around an engineering for social justice (ESJ) approach. Both PBL units were designed as ill-structured problems and tasked teams of students to weigh competing factors relating to economic, environmental, and sociocultural impacts to each community in order to justify a final engineering recommendation. In each PBL unit, guided reflection prompts recorded individual student attitudes and beliefs about the appropriateness in using the HCD process and ESJ approach to meet the needs of each community. The focus of this paper is on the instructional design strategy and preliminary analysis of the qualitative data. Our early observations suggest that students perceived value in the engineering for social justice approach, and they identified specific community needs rooted in economic, environmental, and sociocultural dimensions. Yet, many students struggled to connect those community needs to their engineering project efforts. This early interpretation suggests that it is viable to use the ESJ approach in an introductory engineering mechanics course to raise student awareness around social justice issues.**

Keywords*— *Culturally relevant pedagogy, human-centered design, engineering for social justice, instructional design

I. Introduction

Typical engineering mechanics curricula emphasize technical concepts leaving students ill-equipped to navigate the complex interplay between those same concepts, engineering design, and social contexts. This shortcoming reinforces student beliefs that engineering is a solely technical enterprise, devoid of social responsibility [1-2]. This lack of awareness has negatively impacted non-dominant and marginalized groups, who are not proportionally represented within engineering practice [3]. An incomplete consideration of broader social contexts has contributed to past oversights in engineering solutions (e.g., the Eisenhower Interstate system supplanting communities of color in urban centers [4], airbags failing to deploy for female drivers [5], etc.), which manifests itself in new oversights today (e.g., algorithmic decisions based on biased, incomplete, or past discriminatory data sets that are easily transferred into new predictive models and decision making scenarios [6]). The persistent disconnect between engineering technical concepts, engineering design, and social contexts is glaringly incompatible with the increasingly diverse and multi-ethnic nature of the United States, which is projected to be a majority-minority nation by 2043 [7]. Engineers of the 21st Century must be capable of designing solutions that fully meet the needs of all groups, and they must be acutely aware of systemic inequities and injustices that engineering can both propagate and challenge.

Although there are means of raising an engineering student's awareness of social contexts with case studies [8] or service learning [9], those means are limited in prompting individuals to challenge inequities and injustices pervading society [10]. Freire argued for *conscientization* – or critical consciousness – for persons to take critical action against their oppressive conditions [11]. In this paper, we define critical consciousness as an individual's awareness of the injustices in the world (particularly regarding economic, environmental, social, and political dimensions) and their propensity to challenge those injustices. Ladson-Billings included critical consciousness in her theory of culturally relevant pedagogy (CRP), which includes three tenets: academic mastery, multicultural competence, and Freire's critical consciousness [12]. While CRP practices have been adopted broadly in K12 education, those practices have not been broadly explored in engineering mechanics curricula [13]. Nevertheless, a growing number of researchers have explored various techniques to actualize CRP within engineering curricula, including redesigning syllabi [14], inspecting 'hidden curriculum' [15], leveraging 'funds of knowledge' in learning [16], and examining power inequalities in engineering work [17]. Yet, very few evidence-based instructional practices exist that specifically target the development of critical consciousness in engineering mechanics class contexts [18].

To overcome this gap in the instructor's toolbox, the authors explored how CRP can be infused within instructional practices in an engineering mechanics class context. Specifically, we designed and created ill-structured project-based learning (PBL) units framed under the design frameworks of the human-centered design process and the engineering justice approach, as described by Leydens and Lucena [19]. The successful creation of such instructional practices holds the promise of better equipping faculty who seek to prepare their students to approach engineering design with broadened perspectives toward non-dominant, marginalized groups in our increasingly diverse society.

II. Literature Review

A. Project-Based Learning (PBL)

Project-based learning (PBL) is a pedagogical approach that contextualizes learning activities over an extended period of time centered around an open-ended problem that yields divergent solutions [20]. PBL units in engineering education are often ill-structured problems that mirror real-world scenarios that engineers face in practice [21]. Ill-structured problems are designed to have incomplete information and

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competing goals, which necessitates individuals to participate in deliberative learning practices to justify their decisions [22]. Engineering student resistance to PBL units can be high if the active learning activities are not carefully supported, such as scaffolding successive deliverables with consistent feedback [23]. When designed and executed in accordance to best-practices, PBL fosters engineering student competence and confidence in solving engineering problems that mimic what they would see in engineering practice.

B. Human-Centered Design vs. Engineering Justice

The human-centered design (HCD) process is an approach espoused by the Stanford d.school and IDEO, which has been adopted in curricula at various engineering institutions across the United States for its particular emphasis on fostering empathy in engineering students [24]. Specifically, the HCD process centers on the creation of solutions using five steps (empathize, define, ideate, prototype, and test) within the three phases of design thinking (inspiration, ideation, and implementation). Leydens and Lucena examined the use of HCD in engineering design processes and categorized three foci of HCD: on design technology, on a specific user or client, or on a broader community [19]. The latter two are capable of fostering empathy in engineering students; yet, they are limited in fostering the identification of social injustices stemming from empathy exercises. Leydens and Lucena proposed a new design framework called the engineering for social justice (ESJ) approach. The ESJ approach offers seven steps to approach engineering design that brings to the forefront social justice issues and raises attention to rectifying those injustices with engineering solutions [19].

In the first two steps of the ESJ approach, Leydens and Lucena describe *contextual listening* as a precursory step to a *needs analysis*. Contextual listening is an empathetical practice in which the engineer seeks to understands a user's (or affectee's) perspective without bias nor consideration toward how that perspective informs or constrains an engineering problem at hand. Instead, the outcome of contextual listening is for the engineer to discover the community's needs in its broadest terms. After gaining this knowledge, the engineer then conducts a needs analysis that articulates the present-day needs that a community faces, irrespective of the engineering problem at hand. These efforts are similar to the HCD's empathy and define steps, yet shift the focus toward broader considerations in a community.

Leydens and Lucena offer three additional steps in the ESJ approach, particularly when ideating solutions. When possible, engineers should ideate solutions that *increase human rights*, like those defined by the United Nations [25]. Engineers should strive to incorporate means in their ideated solutions that *increase opportunities* to alleviate the community's needs as discovered from a needs analysis. Lastly, engineers should ensure a commensurate *increase in resources* to support the community's ability to access those new opportunities. In the last two steps of the ESJ approach, Leydens and Lucena implore the engineer to account for the long-lasting impact of the engineering design by developing solutions that *reduce present and future risks and harms to a community* and *enhance human capabilities* [26].

III. Instructional Design

Two 8-week-long PBL units were backward-designed to achieve mirrored deliverables using an HCD process and an ESJ approach. The first PBL unit was framed under the HCD process; and it centered on the design of a new, fictitious truss bridge at a nearby community with high traffic congestion. The second PBL unit was framed under the ESJ approach, and it centered on the design a new amusement park attraction in the immediate vicinity of the campus. Both PBL units were designed as ill-structured problems where student teams were tasked to weigh the consequences of siting their solution at one of three pre-determined candidate sites. Each candidate site represented a complex intertwinement of economic, environmental, and sociocultural impacts to the respective communities. In the first PBL unit, the selection of any site for a new road bridge and associated road improvement project would directly impact specific residential subdivisions, a specific suite of businesses, a community college campus, and privately-owned agricultural land. In the second PBL unit, the selection of any site for a new amusement park would directly impact an arboretum, a broad suite of businesses, a low-income migrant residential area, and a historically black neighborhood association. The selection of any site would necessitate encroaching or seizing any combination of these economic, environmental, and/or sociocultural entities.

The dissimilar number of steps in the HCD process and ESJ approach required an examination of how to scaffold the PBL units such that they resulted in mirrored deliverables. We trifurcated the 5 steps of the HCD process and the 7 steps of the ESJ approach into three design phases: 1) Empathy and Understanding, 2) Ideating Divergent Solutions, and 3) Validating Long-Lasting Solutions. The specific schedule of deliverables and associated learning outcomes are detailed in Table I. At each phase, the instructor provided additional resources, which served to support the learner effort of using either the HCD process of ESJ approach to design their engineering solution. The instructor offered instruction on interviewing, contextual listening, customer profile maps, and persona design to support students in completing Deliverable 1. The instructor provided written feedback of the first deliverable before the second phase, Deliverable 2, was initiated. At that phase, the instructor provided additional instruction on problem statements, needs statements, and value propositions. The instructor differentiated *needs statements* in the ESJ approach from *problem statements* in the HCD process by encouraging students to explore each candidate site's history, demographics, and site conditions that are not directly related to *engineering constraints* of siting the amusement park. In the final phase, Deliverable 3, the first PBL unit using the HCD process tasked students to maximize safety and to minimize costs demonstrable via a prototype, and the second PBL unit using the ESJ approach tasked students to maximize community resources and to minimize risks and harms to the broader community.

In each team-based deliverable, guided reflection questions prompted individual student attitudes and beliefs about the appropriateness in using the HCD process in the first PBL unit and the ESJ approach in the second PBL unit.

IV. Research Objectives and Methodology

A growing number of instructional approaches are discoverable in the literature that can positively shift students' academic mastery of technical concepts, enhance multicultural competence, and foster critical consciousness. The objective of this research is to explore how scaffolded PBL units can support shifts in students' multicultural competence and critical consciousness, as discoverable in an exploratory mixed-methods, sequential study. Pre- and post-surveys were deployed based on validated instruments found in the social sciences literature. Focus groups will generate qualitative narratives that add insight to the quantitative measures. As a WIP, only a preliminary qualitative analysis of the guided reflections is presented at this time.

TABLE I. SCAFFOLDED DELIVERABLES

Deliverables	*HCD-Based PBL*	*ESJ-Based PBL*
Deliverable 1 – Technical report focused on empathizing and understanding.	**Discover** relevant background information of the truss bridge candidate sites. **Create** stakeholder customer profile maps for each candidate site using interviews and engineering research.	**Discover** relevant background information of the amusement park candidate sites. **Create** stakeholder personas for each candidate site using contextual listening and engineering research.
Deliverable 2 – Technical report focused on ideating divergent solutions.	**Summarize** the HCD process. **Create** 'problem statements' as informed by an exploration of the candidate sites. **Create** value proposition statements for each candidate site.	**Summarize** the ESJ approach. **Create** 'needs statements' as informed by an exploration of structural conditions of the candidate sites. **Create** value proposition statements for each candidate site.
Deliverable 3 – Technical report focused on validating long-lasting solutions.	**Create** a prototype that maximizes safety and minimizes cost for a candidate site. **Validate** your prototype.	**Create** a prototype that maximizes community resources and minimizes risks and harms for a candidate site. **Validate** your prototype.
Deliverable 4 – Presentation focused on justifying a solution in the context of a design methodology (HCD or ESJ).	**Justify** your technical design recommendation at a specific site. **Justify** how your final recommendation creates value for the local community.	**Justify** your technical design recommendation at a specific site. **Justify** how your final recommendation creates value for the local community, possibly enhancing the community's human capabilities.

The 36 participants in this study were enrolled at a public, primarily undergraduate, predominantly white institution in the Mid-Atlantic region of the United States. Quantitative measures regarding age, gender, and ethnicity were collected via survey but are not reported at this time. Qualitative measures regarding the participants' views were collected via guided reflection prompts. The guided reflection prompts were administered to the students throughout the semester to gain insight into their changing views and to inform the development of a protocol for a focus group. The reflection prompts were designed to link the learner's experience to the learning objectives [27]. Each individually written reflection was submitted alongside the team-based report, which was used to assess 1) technical concepts developed in the course and 2) engineering design (HCD or ESJ) efforts.

The discussion in this paper draws on student reflections obtained from the following prompt in the second PBL unit: *How was your understanding of the stakeholders' needs better understood as a result of your efforts using the engineering justice approach?* The lead researcher inspected the reflections and recorded his interpretation using memoing to expand on observed nuances, unpack inferences, and attempt to find meaning in the generated data [28]. The preliminary qualitative data analysis focuses on identifying emergent categories discerned in the memoing. The lead researcher was the instructor, meaning that his participation as instructor directly influenced the research outcomes.

V. RESULTS AND DISCUSSION

Four emergent, hierarchal categories were discerned from the memoing, and they suggest that students either:

1) identified generic stakeholders yet did not incorporate those generic stakeholder interests or needs into their engineering project effort;

2) identified generic community interests or needs and struggled to incorporate those interests or needs into their engineering project effort;

3) identified specific community interests or needs and balked at incorporating those interests or needs into their engineering project effort; or

4) identified specific community interests or needs and fully incorporated those interests or needs into their engineering project effort.

Broadly, the vast majority of students articulated finding *value* in the ESJ approach in their engineering project work, and many identified relevant stakeholders at each candidate site. Some students, however, limited their analysis to *generic stakeholders* devoid of any specific characteristics associated to any candidate site. One team, for example, acknowledged "*local businesses and homes being destroyed for the amusement park*" and that "*these [affected] people will get some form of compensation*." These remarks indicate that the students are aware that there will be negative consequences as a result of their project efforts and that financial compensation is a means of overcoming shortcomings in their decisions. This sentiment is elaborated in one student's reflection, stating, "*this project was a little trickier because many of our stakeholders would probably not like the amusement park, but we were able to find ways around it*." This team typified those who identified generic stakeholders and elected not to incorporate their interests or needs into the project effort.

Other students acknowledged the existence of *generic communities*, yet they struggled to identify specific community interests or needs opting, instead, to generalize those interests. One team, for example, was *aware* of certain communities in their overall project efforts. They noted, for example, that there are intrusions into the "*local ecosystem contained within the arboretum*," should an amusement park be sited at that candidate site. However, the team did not distinguish between different residential areas at each candidate site, despite key differences in their socioeconomic makeup. This suggests that these students identified *generic* aspects of communities, without having found *nuanced*, *specific* characteristics of each community. Their inability to do so resulted in their inability to inspect any economic or sociocultural dimensions of any community. Instead, this team discussed how the term *engineering justice* was too broad, so they opted to "*narrow it down to sustainability, with a focus on designing a theme park that uses renewable energy, use recyclable materials, minimize energy usage, and find* *park boundaries that have minimal impact on the local ecosystem… because this fits our skills and interests*." In their articulation, the team opted to generalize the community's interests and needs to those that they were more familiar with. In doing so, the team struggled to connect how their project effort can alleviate any community needs at all. Yet, this team noted the value of the ESJ approach and gained awareness of competing factors in their engineering project efforts, as evidenced in their individual reflections. One student wrote, "*it was difficult at first because we kept thinking about what we needed in the amusement park. What we didn't think about was what the surrounding community needed*." Another said that "*using the engineering justice approach helped me think about aspects of my choices that were outside the technical realm. For me, it helped me broaden my scope on issues and better take into account the hidden need that the stakeholders were faced that were not necessarily related to the park*." The students seemingly expressed an understanding that stakeholders do not simply exist to inform the constraints of the engineering problem, yet they struggled to use the community's interests or needs to inform their project effort.

Most students identified *specific communities* within the candidate sites, such as the arboretum, specific historic neighborhoods, or specific businesses. However, they balked or hesitated to use those community interests or needs to inform their engineering project efforts. One team delved deeply, on their own accord, into literature offering a quote by Campbell to inform their outlook on the project effort. They quoted that "*if engineers are unaware of the values driving their efforts, then [they] are unlikely to create long-lasting solutions to the problems we hope to address*" [29]. This team indicated that the construction of an amusement park at any site would pose significant ethical dilemmas, whereby they offered: (1) that to cut down trees at an arboretum would reflect poorly on efforts to curb climate change amidst deforestation issues in the world; and (2) that to uproot a historic, African-American neighborhood would go against its long history of preservation efforts against gentrification and eminent domain seizures. Each student on this team remarked in their reflections about how they judged these specific communities to be as equally important as the fictitious client. One student said that they revisited their earlier research and persona development efforts in light of a better understanding of the community's needs. Specifically, the student noted that being newly aware of "*the needs of the community made me actually go back to my [earlier] work and change the direction of the project*." Despite their acknowledgement of the competing factors at each candidate site, the team felt conflicted incorporating all elements of that newly gained information. Another student wrote in their reflection: "*I felt that it was a lot easier to get emotionally invested into the stakeholder's needs which is a good thing and a bad thing. It can be extremely good and progressive for the project if the engineer is able to control those emotions and stay objective, but if they are unable to do so then they can easily slip into a more subjective approach to the project which will lead to skewed results*." This reflection suggested that despite having proposed a preliminary solution that better met the needs of the stakeholders, students might feel uneasy in defending these solutions since it "inappropriately" draws from their emotions and "skews results." Such hesitation is likely engrained in preconceived, faulty notions that engineering is a solely technical process and to deviate from such thinking is to deviate from defensible engineering recommendations.

Very few students used the ESJ approach to identify specific community needs and fully incorporate those elements into their engineering project effort. One team systemically challenged the selection of any candidate site because of the negative consequences to a specific arboretum, a specific low-income residential neighborhood, and a specific historic neighborhood. One student elaborated in their reflection that in choosing Site A, "*nature would be destroyed*;" in choosing Site B, specific residential communities "*would be negatively impacted*;" and in choosing Site C, it "*would directly contradict with [the historic neighborhood's] mission to preserve the area*." In an earlier project submission, that team had proposed selecting a new site on agricultural land approximately two miles away from the campus in order to avoid actualizing any such consequences. In written feedback, the instructor challenged the team to find a solution in the urban core of the campus community (i.e., the original prompt) since the PBL-unit reflected a real-world scenario where development in major urban centers cannot readily access undeveloped agricultural land. The team responded to that feedback in their next project submission by prototyping one of the candidate sites as a small nature park (displacing zero residents) filled with small, non-intrusive attractions priced in order to welcome the low-income residents into the new community gathering place. One student wrote about this early prototype that, "*creating the needs statement for Site A was enlightening for me, as it helped me to realize that the answer to Site A's needs was a nature park, as opposed to an amusement park*." The student added that they had "*an important realization that the idea of a quiet, low-key nature park [wasn't] incompatible with the needs of the client*." This team was among the very few who embraced the ESJ approach to explore alternative solutions that more broadly met the community's interests or needs.

VI. Conclusions and Future Work

The preliminary qualitative analysis of this WIP suggests that it is viable to use the ESJ approach in an engineering mechanics course to raise student awareness around justice issues, yet its adoption is limited in its ability to foster critical consciousness in a singular deployment. Most students found value in using the ESJ approach as they did with the HCD process, yet the majority of students struggled to inform their engineering project efforts with discovered community needs or interests. A minority of student teams did, however, attempt to revise their project efforts to incorporate community needs in drafting an engineering solution; yet, those students felt a discomfort doing so since they felt it introduced a "subjective approach" to engineering. Such a sentiment in the eyes of students creates challenges for instructors to use design methodologies that seek to introduce subjective approaches, like justice issues, to engineering design. Nevertheless, the early interpretation summarized in this paper suggests that it is viable to use the ESJ approach in an engineering mechanics course to raise student awareness around justice issues, and that more instructional support is needed to encourage student use of the ESJ approach to address justice issues. It is also apparent that student resistance to incorporating subjective approaches must be continually challenged beyond singular instances in engineering curricula (i.e., a singular class).

The remaining work in this study are to develop a coding scheme of the qualitative data, conduct a quantitative analysis of pre- and post-surveys, and generate additional qualitative data from focus group interviews.

REFERENCES

[1] Bielefeldt, A. R., & Canney, N. E. (2016). "Changes in the social responsibility attitudes of engineering students over time." Science and Engineering Ethics 22 (5): 1535-1551.

[2] Cech, E. A. (2014). "Culture of disengagement in engineering education?" Science, Technology, & Human Values 39 (1): 42-72.

[3] National Science Foundation (NSF), National Center for Science and Engineering Statistics (NCSES). 2019. Women, Minorities, and Persons with Disabilities in Science and Engineering: 2019. Special Report NSF 19-304. Alexandria, VA. Available at https://www.nsf.gov/statistics/wmpd.

[4] Avila, E. (2014). The folklore of the freeway: Race and revolt in the modernist city. U of Minnesota Press.

[5] Margolis, J., & Fisher, A. (2002). Unlocking the clubhouse: Women in computing. MIT press.

[6] Calders, T., & Žliobaitė, I. (2013). "Why unbiased computational processes can lead to discriminative decision procedures." In Discrimination and Privacy in the Information Society (pp. 43-57). Springer, Berlin, Heidelberg.

[7] Colby, S. L., & Ortman, J. M. (2015). "Projections of the Size and Composition of the US Population: 2014 to 2060. Population Estimates and Projections." Current Population Reports. P25-1143. US Census Bureau.

[8] Alpay, E. (2013). "Student-inspired activities for the teaching and learning of engineering ethics." Science and Engineering Ethics 19 (4): 1455-1468.

[9] Boyle-Baise, M., & Langford, J. (2004). "There are children here: Service learning for social justice." Equity & Excellence in Education 37 (1): 55-66.

[10] Santiago-Ortiz, A. (2019). "From critical to decolonizing service-learning: Limits and possibilities of social justice-based approaches to community service-learning." Michigan Journal of Community Service Learning 25 (1): 43-54.

[11] Freire, P. (1973). Education for critical consciousness (Vol. 1). Bloomsbury Publishing.

[12] Ladson-Billings, G. (1995). "Toward a theory of culturally relevant pedagogy." American Educational Research Journal 32 (3): 465-491.

[13] Castaneda, D. I., & Mejia, J. A. (2018). "Culturally relevant pedagogy: An approach to foster critical consciousness in civil engineering." Journal of Professional Issues in Engineering Education and Practice 144 (2): 02518002.

[14] Gorski, P. C. (2009). "What we're teaching teachers: An analysis of multicultural teacher education coursework syllabi." Teaching and Teacher Education 25 (2): 309-318.

[15] Villanueva, I. (2018). "What does hidden curriculum in engineering look like and how can it be explored?" In Proceedings of the American Society of Engineering Education Annual Conference and Exposition, Minorities in Engineering Division (pp. 1-16). Salt Lake City, Utah.

[16] Wilson - Lopez, A., Mejia, J. A., Hasbún, I. M., & Kasun, G. S. (2016). "Latina/o adolescents' funds of knowledge related to engineering." Journal of Engineering Education 105 (2): 278-311.

[17] Nieusma, D., & Riley, D. (2010). "Designs on development: engineering, globalization, and social justice." Engineering Studies 2 (1): 29-59.

[18] Castaneda, D. I. (2019). "Exploring critical consciousness in engineering curriculum through an ill-structured problem." In 2019 IEEE Frontiers in Education Conference (FIE) (pp. 1-5). IEEE.

[19] Leydens, J. A., & Lucena, J. C. (2017). Engineering justice: Transforming engineering education and practice. John Wiley & Sons.

[20] Kokotsaki, D., Menzies, V., & Wiggins, A. (2016). "Project-based learning: A review of the literature." Improving Schools 19 (3): 267-277.

[21] Jonassen, D., Strobel, J., & Lee, C. B. (2006). "Everyday problem solving in engineering: Lessons for engineering educators." Journal of Engineering Education 95 (2): 139-151.

[22] Hoffmann, M., & Borenstein, J. (2014). "Understanding ill-structured engineering ethics problems through a collaborative learning and argument visualization approach." Science and Engineering Ethics 20 (1): 261-276.

[23] Tharayil, S., Borrego, M., Prince, M., Nguyen, K. A., Shekhar, P., Finelli, C. J., & Waters, C. (2018). "Strategies to mitigate student resistance to active learning." International Journal of STEM Education 5 (1): 1-16.

[24] Zoltowski, C. B., Oakes, W. C., & Cardella, M. E. (2012). "Students' ways of experiencing human - centered design." Journal of Engineering Education 101 (1): 28-59.

[25] United Nations. General Assembly. (1949). Universal declaration of human rights (Vol. 3381). Department of State. United States of America.

[26] Nussbaum, M. C. (2001). Women and human development: The capabilities approach (Vol. 3). Cambridge University Press.

[27] Hatcher, J. A., & Bringle, R. G. (1997). "Reflection: Bridging the gap between service and learning." College Teaching 45 (4): 153-158.

[28] Saldaña, J. (2014). "Coding and analysis strategies." Chapter in The Oxford Handbook of Qualitative Research.

[29] Campbell, R. C. (2016). "Engineering to Care: Exploring Engineering in Humanitarian and Social Justice Contexts through a Lens of Care Ethics" (Doctoral dissertation). University of Washington.