Integrating Disability Studies into an Engineering Service-Learning Curriculum

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Abstract

Disability Studies and Engineering for Development share the common goal of improving disabled people's access to their communities, but these perspectives are rarely integrated. Engineering for Development (E4D) is a multidisciplinary field emphasizing collaboration to create sustainable solutions to global challenges, particularly those affecting under-served populations. In contrast to most engineering fields, the social model of disability, which is prominent in the field of Disability Studies (DS), argues that disability is created by an inaccessible society rather than impairments of individuals' bodies or minds. While increased accessibility is a vital civil rights issue, the social model argues, disabled people do not need to be "fixed." A newly designed E4D service-learning course at Mercer University incorporates key principles of DS to facilitate students' understanding of appropriate technologies and respect for disabled technology users' perspectives and autonomy. This paper focuses on three areas of course development and classroom applications: 1) Instructor approaches to presenting lectures and facilitating discussions on accessibility, mobility, and assistive technology through a DS lens; 2) Assessments of students' ability to synthesize DS topics and engineering design principles; and 3) Short- and medium-term impacts of exposure to DS topics on students' attitudes towards the relationship between disability and engineering.

Keywords

Accessibility, mobility, engineering for development, international service learning, interdisciplinary coursework

Introduction

Disability Studies (DS) and Engineering for Development (E4D) both address the needs of disabled people and emphasize the importance of community involvement in solution development,[1] leading to unique opportunities and challenges when integrating the two. For example, DS tenets emphasizing the importance of autonomy and disabled people's right to make their own decisions complement E4D principles of user-led services. At the same time, "cures" that are resisted by many disabled activists are oftentimes portrayed as positive humanitarian accomplishments by the E4D field. While previous literature has identified the potential benefits of integrating DS and engineering coursework,[2–4] none of these approaches have addressed E4D specifically, and this relationship remains widely unexplored. This paper describes the process of implementing a course module on Accessibility and Mobility into an E4D service-learning program and the impacts of this module on students' attitudes towards the relationship between disability and engineering, as well as towards disability more broadly. The goal of both the module and this paper is to propose an alternate lens of considering disability in engineering coursework, conversations, and projects—that disability is not an inherently negative experience, disabled people are authorities on their own needs, and engineers (both disabled and nondisabled) play a vital role in creating accessible communities.

Background

This section contextualizes the course within the history of the service-learning program in which it was offered and the broader history of the relationship between disability and STEM fields.

Program Background

The E4D Program at Mercer University focuses on sustainable solutions for people and the planet.[5] The program works with stakeholders internationally and locally on appropriate solutions to improve health and livelihoods. Over the past few years, Accessibility and Mobility has become a key research-service-learning component within the E4D program. Related ongoing E4D work in the Dominican Republic has been done through the university's Mercer On Mission international service-learning research program. This program started working with communities in the Dominican Republic in 2017, with a focus on improving environmental health (related to water, sanitation, hygiene, and indoor air).[6] Since 2018, Accessibility and Mobility has been added as a focus area.

Disability and STEM

Disabled students are underrepresented in STEM fields and have an even smaller presence in engineering specifically.[7] Disabled students who do pursue a STEM degree are less likely than their peers in other fields to access accommodations.[8] Accommodations for disabled students, Amy Slaton argues, "challenge ideas central to the culture of STEM," and the use of accommodations risks calling into question a student's self-reliance, self-discipline, mastery of material, and even character.[9] Even students who do utilize necessary accommodations often can only do so after receiving a sufficient diagnosis and documentation from a healthcare provider, which poses yet another barrier to equitable education for low-income disabled students. Current standard practices at postsecondary institutions place the burden of seeking accommodations on the disabled student and "do not address barriers embedded within the curriculum design."[10]

In fact, the full extent of barriers in engineering curricula and environments is not even known. One literature review aiming to identify barriers faced by physically disabled students in STEM laboratories concluded that "a need exists to help uncover barriers students with disabilities encounter in STEM," as the available literature did not identify these obstacles in sufficient detail.[11] According to Slaton, disabled identity is "underexplored in STEM education theory, marginalized in institutional planning, and nearly invisible in critical social scientific studies of those fields."[9]

These factors compound one another to create a degree program that is difficult to navigate both physically and socially for disabled students. However, almost no literature addresses the other negative impact of the lack of acceptance of disability in engineering fields, which is the effect on nondisabled students. While creating a more equitable environment for disabled engineering students is vital for their own sake, it is also important for nondisabled students to learn to engage with disability issues and recognize instances of discrimination or affirmation in engineering design, both because these students will almost certainly make decisions in their careers that affect disabled people and because they will likely one day become disabled themselves. It is the goal of the authors that by incorporating key principles of Disability Studies into engineering curricula, engineering educators will instill in disabled students a sense of pride, capability, and belonging, as well as teach nondisabled students that disability is not a negative or tragic experience, causing a ripple effect of de-stigmatization in which nondisabled engineers create accessible and affirming environments in industry and academia.

Course Format

The class consisted of ten students from five different engineering disciplines: biomedical, civil, environmental, industrial, and mechanical. Due to the COVID-19 pandemic, the course was delivered online through 3-hour classes four days a week for three weeks. Most of these classes consisted of synchronous Zoom sessions for presentations and discussion. The Zoom breakout rooms function was used for small-group discussions (with students then 'reporting out' from their unmonitored small group discussion, in a plenary session with all students and instructors). All Zoom classes were recorded and available to students through Echo360. The asynchronous classes consisted of videos and articles for students to consume independently.

Course Content

The DS portion of the course consisted of two 2-hour sessions of lecture, small group discussion, and class discussion, followed by reflective journaling and questions on a final take-home exam.

Lecture Content

DS lectures were divided into two categories: Accessibility, which covered common models of disability, ableism and access barriers, and universal design; and Mobility, which covered common mobility aids, informational and financial barriers to mobility, and the concept of fluid mobility. Both categories addressed the applications of these topics to the field of E4D.

Four models of disability were presented: charity, medical, social, and diversity. The charity model describes the belief that disability is caused by divine punishment and it is the role of religious institutions to care for disabled people. The medical model is the most popular interpretation of disability in STEM fields, including engineering disciplines such as biomedical engineering. This model locates the cause of disability in physical and/or neurological problems and argues that individuals with disabilities require medical intervention. The social model of disability, developed and popularized during the beginning of the modern disability rights movement, posits that disability is caused by an inaccessible society. Therefore, under this framework, the oppression of disabled people must be ended through civil rights legislation which allows equal community participation. The diversity model, one of many recent variations proposed to address shortcomings of the social model, describes the belief that disability is a natural form of human variation. Accessibility cannot be achieved through legislation oriented around a universal solution, this model argues, because disability itself is diverse; similarly, disability and ability are not binary.

Six categories of mobility aids were discussed: canes, crutches, walkers and rollators, forearm rollators, manual wheelchairs, and powered devices. Differences within these categories were also mentioned, such as the biomechanical impacts of axillary versus forearm crutches. Reasons why an individual might choose each device were explained, including cost, size, benefits, and risks. Barriers to mobility such as lack of access to healthcare and negative impacts of inaccurate media representation were covered, as was the concept of fluid mobility—that some individuals' mobility needs vary on a seasonal, weekly, or daily basis depending on their environment and available energy.

The connections between DS and E4D that were discussed included the importance of appropriate technologies and community-led solutions. In a documentary shown earlier in the class, water pumps failed to serve the communities they were intended to benefit when the engineers did not consider the community members' needs and values;[12] similarly, assistive technology that does not meet the environmental needs of its intended users suffers from a high attrition rate in developing regions.[13] DS emphasizes that disabled people are the authorities on their own bodies, experiences, and needs. Therefore, engineers should incorporate users' desires and needs into assistive technology designs rather than acting on stereotypes such as that all wheelchair users are non-ambulatory or all amputees want their prostheses to appear as similar to a flesh limb as possible. For example, a powered wheelchair designed with the assumption that all users will be paralyzed will include expensive features that ambulatory users will not need; additionally, such assumptions contribute to the harassment of people who stand up from their wheelchairs in public.[14]

Class Discussion

The small-group discussion prompts for the Accessibility section were (1) to share an example of how one or more models of disability have been used in engineering and development projects and discuss how these beliefs affect disabled engineers and community members and (2) to discuss some of the barriers that disabled people face and what responsibility, if any, society has to address these barriers. Prompt (2) was adapted from Dr. Doe Buchli's Introduction to Disability Studies course material. Students commented on the negative impacts that occur when society does not consider the breadth and diversity of disability. They discussed the problem with pity and offering visibly disabled people undesired assistance, which has roots in the charity model. Students also asked insightful questions, such as how engineers can differentiate between unwanted "cures" versus alleviating the negative impacts of a disability.

The small-group discussion prompts for the Mobility section were (1) to share examples of incorrect mobility aid usage in the media and (2) to discuss how engineers can address social, informational, and financial barriers to mobility. When reflecting on their responses with the class, students said that it was difficult to think of examples of incorrect mobility aid usage because they were unable to think of any visibly disabled characters at all. Students emphasized the importance of distributing information on correct mobility aid usage and the role of engineers in accomplishing this goal. They also discussed the importance of education in dismantling stereotypes. Students' questions covered cultural, legal, and technical topics, including the differences between countries in approaches to accommodations, the gap between current legislative requirements and full accessibility, and the impacts of social pressures on use of assistive technology for people in different age groups.

The class discussions also addressed the tension between Disability Studies and Engineering for Development, as well as engineering more broadly. For example, a documentary assigned as part of the asynchronous coursework[12] described cochlear implant technology as a benefit of humanitarian engineering without acknowledging the risks of such technology or the extensive debates in d/Deaf communities about its use. When these points were raised in discussion, some students wrestled with the possibility of medical model-style interventions into disability being flawed or unnecessary.

One cause of this tension is likely the culture of compulsory able-bodiedness[15] cultivated in engineering fields, E4D included. Drawing on the work of Adrienne Rich and Judith Butler in explaining how heterosexuality is assumed and enforced by a patriarchal and heteronormative society, McRuer explains that an ableist society treats able-bodiedness as the natural state of all bodies; deviation (i.e. disability) is considered something undesirable and the responsibility of the disabled individual to remediate.[15] Since able-bodiedness is assumed to be the default, it becomes a “nonidentity,” invisible until highlighted through contrast with a disabled body. Slaton argues that “STEM elides bodily experience,”[9] instead assuming—and therefore enforcing—the able-bodiedness of its participants. McRuer suggests that this seemingly innocuous assumption is then perpetuated in both the macro- and microcosm, leading nondisabled members of a society, culture, or even degree program to aim for an increasingly unattainable ideal of able-bodiedness, to the detriment of themselves and their disabled peers. These internalized values then lead individuals to treat disability as a quality that is undesirable or even deserving of eradication.

Reflective Journals

Reflective journaling has become increasingly popular in many disciplines as a tool to promote student self-reflection, developmental progression, and critical thinking[16–17] to benefit students and instructors alike. For students, studies suggest that this activity improves learning,[18] provides feedback, fosters self-expression, sparks critical thinking,[19] promotes personal and professional development,[20] and assists in the development of emotional literacy.[21] Studies conclude that reflective journals give instructors invaluable insight into student development,[19] including the students’ understanding of course content and challenges faced in learning/retaining the material.[21] Within the context of the course content on Accessibility and Mobility, reflective journals provided space for the students to engage further with the learned material, consider the ethical/moral class discussion components, take on the perspective of other people, and apply their learning to guide their careers as engineers.

Reflective journals are a common requirement in the university’s Mercer On Mission program. Students completed a reflective journaling assignment, wherein they documented reflective and critical thoughts related to class lectures, assignments, and their personal lives. The goal of this assignment was to promote students’ reflective thinking on the interconnections between class content and their personal values, beliefs, sense of purpose, and vocation. The assignment considered a complete entry as the documentation of a reflective thought, comprising three components: (1) selection of a current event or learned material as the entry subject, (2) analysis of event/learning through the lens of the students’ past experiences and perspective, and (3) projected implication/insight of the analysis into the student’s future life. Students were provided a set of reflective journal questions and entry topics, and were encouraged to write beyond this list. Each student composed and submitted at least six entries, over the duration of the course, which were then critically reviewed by instructors.

Journals were reviewed and graded based on the completeness of each entry. Several different types of feedback remarks were provided to students including: affective empathy for emotions/circumstances; a call to dig deeper into topics that were superficially mentioned in the journal; a challenge to reflect rather than recount events; challenges to students' viewpoints (e.g., ideological debate); addressing challenges to student learning/retention; a call for balance/duality among journal entries (i.e., discussing both pleasant and unpleasant); and appreciation/gratitude for insights. The depth of journal entries varied from student-to-student, with some providing reflective insight into their personal character and affect to explain their receptivity of course content, while others tended to make nonspecific statements about their feelings and preferences. Journals completed later in the course tended to include more reflections on students' self-view. The feedback provided on their reaction and preference for course content was valuable for adjusting course delivery and future content.

Assessment

Students' understanding of DS topics presented in class and ability to apply these topics to engineering and service-learning scenarios were assessed through two multi-part questions on the final examination (see Appendix). The most common sources of point deductions on these questions were, respectively, an incomplete definition of the charity model of disability and a failure to mention environmental factors that may affect a user's choice of mobility aid(s), such as whether the individual's apartment has an entrance without stairs. Overall, students were able to recognize areas of discrimination in their daily lives and develop engineering projects related to disability, but had difficulty articulating how these projects may or may not ascribe to a certain model of disability.

Impact on Students

Student responses in class discussion, reflective journal entries, and assessment questions were analyzed for short-term impacts of DS material on their attitude towards E4D and engineering at large. A brief, anonymous survey was distributed 12 weeks after course completion, and all participants provided their feedback, which was analyzed for medium-term impacts.

Short-term Impacts

Overall, students reacted with surprise and frustration when they learned about barriers to healthcare and inaccessible environments on their own campus and in the world at large, describing themselves as "disgusted" by these realities and "very passionate" about the issues. One student reflected that the discussion left them "ready to take the Senate floor and implement change." Students also made connections between the material presented and their own experiences. In an anonymized journal entry, a student expressed that their own disability "made most aspects of life, [including] almost everything that had to do with school, harder," which negatively affected their self-image. The presentation and subsequent discussion resonated with their own journey to accept that they were disabled and not just "a bad kid." This reaction implies that the introduction of DS principles has the potential to change students' perceptions of both disability as a category and themselves as future engineers.

Medium-term Impacts

An anonymous survey was distributed 12 weeks after the completion of the course and completed by all students. The survey consisted of six statements which students responded to using a Likert scale (1 = Strongly Disagree, 2 = Disagree, 3 = Neither Agree Nor Disagree, 4 = Agree, 5 = Strongly Agree). The statements are included below. Table 1 displays the averages, standard deviations, and minima of the responses to the six statements. The maximum response for each statement was 5.

1. The Accessibility and Mobility presentations enhanced my understanding of the relationship between engineering and issues related to disability.
2. The Accessibility and Mobility breakout room discussions enhanced my understanding of the relationship between engineering and issues related to disability.
3. The Accessibility and Mobility full class discussions enhanced my understanding of the relationship between engineering and issues related to disability.
4. The Accessibility and Mobility material was relevant to an engineer of my discipline.
5. The Accessibility and Mobility material would be relevant to an engineer designing assistive technology.
6. The Accessibility and Mobility material would be relevant to an engineer designing technology for use in developing countries.

Table 1: Student responses to survey statements

Statement Number	Average	Standard Deviation	Minimum
1	4.73	0.47	4
2	4.64	0.50	4
3	4.73	0.47	4
4	3.18	1.40	2
5	4.73	0.65	3
6	4.55	0.82	3

Statements 1, 2, 3, 5, and 6 all received an average response of above 4.5, indicating that overall, students strongly agreed that the course format enhanced their understanding of the relationship between engineering and issues related to disability and that the material was relevant to an engineer designing assistive technology or technology for use in developing countries. However, responses varied on whether students considered the material relevant to an engineer of their discipline, with an average score of 3.18 (Neither Agree Nor Disagree), as well as a larger standard deviation and a lower minimum than the other responses.

The survey also included three optional opportunities for free response:

1. (After Statement 4) Please elaborate on your response to the above question. What is your discipline? Why do you think the material is relevant or why not?

2. Please provide any information on how the Accessibility and Mobility material has influenced your perspective on your engineering curriculum, your campus environment, and/or the role of engineers.

3. Please provide any additional feedback about the Accessibility and Mobility material, presentations, and discussion.

Student perspectives on the relevance of the material to their engineering specialty may have varied by discipline. One student acknowledged that it would be important for an engineer of their discipline to “keep disability in mind” during their work but did not consider disability to be a key emphasis of their field. A student from a different discipline said that the course material helped them to realize applications of their discipline in areas related to Accessibility and Mobility. A student from a third engineering specialty commented that while the material was relevant to their career plans, it would not necessarily be as relevant for other students of their discipline.

Responses to the other optional survey questions indicated that the course material raised students’ awareness of accessibility issues in their campus environment and the financial barriers to receiving appropriate assistive technology. Students expressed a newfound desire to make technology affordable and, as one student wrote, “to consider more than just the needs and capabilities of able-bodied people” in their work. One student, while expressing their desire for more engineers to be exposed to the material included in the course, drew explicit connections between the DS and E4D material and values, saying, “As humanitarian engineers, I believe it’s our duty to know more about [Accessibility and Mobility issues].”

Future Work and Conclusion

In future offerings of this course, further time will be dedicated to exploring the tension between certain DS principles, such as the social model’s assertion that the response to disability should be greater accessibility rather than medical intervention, and beliefs that are often standard in engineering disciplines, including E4D. This discussion period will allow students to wrestle with the seemingly contradictory nature of interdisciplinary work, in which two schools of thought may complement—or even complete—each other in some areas but differ greatly in others. Engineering educators such as Summers and Rogge suggest that “inhabiting” the discomfort produced by these differences in perspective is not only beneficial but necessary for engineers because when developing technology related to disability, engineers "will need to inhabit ideas that might seem uncomfortable or push beyond the boundaries of polite in order to create something new, useful, and pleasing."[2]

When the course can be offered in person, activities will be incorporated in which students locate and discuss inaccessible aspects of campus and the community. Additionally, specific information will be added about the relevance of DS to respective engineering disciplines. In future post-course surveys, a statement will be added about the relevance of the Accessibility and Mobility material to the Mercer University engineering curriculum. The university offers one engineering degree with multiple specialties, and many students pursue graduate degrees and/or jobs in other disciplines after graduation, so this question will more accurately reflect student perceptions of the relevance of the course content. In order to reach a broader audience of engineering students, the authors are pursuing the possibility of incorporating the course material as a module in either the Introduction to Engineering Design course required for first-year students or the Introduction to Professional Ethics course required for second-year engineering students at Mercer.

Ultimately, the integration of DS and E4D facilitated students' understanding of the role engineers can serve in dismantling barriers faced by disabled people. As one student stated, "What's the role of the engineer in fixing this? The engineer is the one who writes the manual on this stuff. It's our responsibility to make that information not only accessible but obvious."

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Appendix

Exam Questions and Grading Scale

Question 1:

a. List and define, in your words, the four disability models discussed in class.

b. Choose a model of disability and describe how it has been reflected in a project that (1) was discussed in class, (2) you've implemented, or (3) that could be implemented in the future.

c. From what was covered in class, discuss what could be considered as limitations/inaccuracies for the medical model of disability.

Grading Scale:

a = 4pts (1 per model)

b = 6 pts (approximately 2 for describing a project that fits a model, 3 for correctly naming a model and explaining its relevance to the project, and 1 for details)

c = 5pts

Question 2:

a. List the different types of mobility aids, and describe the reasons (physical, environmental, financial, etc.) why someone would choose each device.

b. Discuss one of the potential health effects of using a mobility aid that isn't fitted properly.

c. Explain how the mobility & accessibility research discussed in class addresses financial and informational barriers to mobility.

Grading Scale:

a = 5 pts (1 per category: canes, crutches, walkers/rollators, manual wheelchairs, powered mobility aids)

b = 4 pts (approximately 2 pts for health effect and 2 pts for fitting issue that causes problem)

c = 6 pts (approximately 3 pts financial, 3 pts informational)