Work-in-Progress: Integrating DEIBJ and Inclusive Design Concepts in an Introductory Engineering Course Using Stand-alone Modules

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WIP: Integrating DEIBJ and Inclusive Design in an Introductory Engineering Course

Introduction

In addressing our world's complex issues, an open and diverse workforce brings more perspectives to problem-solving. Unfortunately, conventional engineering education has often ignored Diversity, Equity, Inclusion, Belonging, and Justice (DEIBJ) issues, perpetuating biases and supressing underrepresented groups. Due to this inequity, educators need to create inclusive environments that value and empower all students and reflect engineering design's collaborative and multidisciplinary nature. Inclusive Design (ID) values solutions that are accessible and user-friendly to individuals of all abilities, backgrounds, and identities, which aligns with engineering education goals. ID encourages empathy and teamwork by having designers consider diverse user group needs throughout the design process. By incorporating inclusive design ideas into the engineering curriculum, educators may prepare students to create technically sound, socially responsible, and globally beneficial solutions. In line with engineering's practicality and solution-oriented approach, this integration directly addresses DEIBJ values. This work-in-progress paper describes a multi-week activity on DEIBJ and ID in a 100-level multidisciplinary engineering design course. Our course introduces basic engineering principles and methods through lectures and labs. Coursework includes computer-aided design, MATLAB programming, and transdisciplinary project creation through hands-on projects. The course uses technical writing, oral presentations, and team-based problem-solving. These strategies improve students' communication and cooperation abilities while teaching basic engineering skills. The DEIBJ/ID activity enhances the course by exposing students to the DEIBJ/ID topics by using active learning approaches like presentations, group exercises, and case studies. These projects and the learning will inspire students to actively and thoughtfully engage with DEIBJ and ID principles, incorporating them into their cognitive processes as they work on future projects. The goal of this paper is to share this idea with the first-year community and also gather feedback to help improve execution and build a system for measuring learning outcomes and module efficacy.

Literature review

Inclusion of DEIBJ and ID in an introductory engineering course is necessary as it ensures students understand these principals early on. Recent pedagogical innovations also stress upon this. Researchers like Cech [1] and Foor & Walden [2] have noted the disconnect between technical training and social responsibility. The education system they propose may bridge this disparity. Cech [1] sees a culture of disengagement where technical skills are valued more than societal concerns, while Foor and Walden [2] cite resistance to diversity efforts, highlighting the necessity for early and proactive DEIB involvement in education. These findings encourage establishing a curriculum that is technically adept and ethically and socially aware. These ideas' practical applications, as reported by [3], [4], [5], [6], reflect our current efforts well. They

recommend dynamic learning settings with inclusive teaching approaches. Capobianco's [5] feminist teaching through collaborative action research supports our use of group activities and case studies to build student accountability and compassion. These methods support our curriculum design and demonstrate a growing scholarly consensus on inclusive and socially conscious engineering education. Previous and ongoing research show that our project is on a clear path, matching a wider trend in education toward more inclusivity and fairness. This sequence of learning experiences ensures that our students can handle complex technical problems and understand the societal impacts of their work, improving their professional effectiveness and empathy.

Methodology and Implementation

During the first week, students receive an introduction to the core principles of DEIBJ as well as ID. The goal is for students to comprehend the significance of these principles in engineering and the opportunities they offer to make the world more accessible and equitable through engineering innovation. Students learn about DEIBJ and then do an active learning exercise on finding their unconscious bias. The idea is to make them aware that unconscious bias is pervasive and sometimes people acting out of their unconscious bias, are not even aware that their actions are biased. In fact, those biases may be in direct conflict with a person's explicit beliefs and values. The overarching goal is to self-examine these biases about diverse populations, accepting them which lets an individual address and reduce them. In the same lecture, the topic of why DEIBJ is important in engineering is addressed. Students are made aware of that engineering requires innovation and problem-solving, and diverse teams offer more perspectives and ideas. Additionally, engineering regularly addresses complicated issues which affects various cultures and global populations. Finally, attracting and keeping excellent engineers requires diversity and inclusion.

During the second week, the emphasis transitions towards the pragmatic implementation of ID through the analysis of case studies and engaging in discussions. The objective is for students to recognize tangible instances of both inclusive and exclusive designs in real-world scenarios. A news article with a video from Daily Mail (as shown in Figure 1 below) is presented to the class as a case study for the students to discuss. Other case studies are also discussed to show how this topic is very relevant to the current state of engineering. Next part of the lecture focusses on ID and the idea of Universal Design. A video that shows how doors can be designed better helps in navigating the discussion on this topic. Other examples such as user-friendly scissors shown in Figure 2 below are shared with the class to encourage discussion on other products that they might think of that can be designed better to be inclusive.

During the third and fourth weeks, students focus on collaborative project work, in which they utilize DEIBJ and ID concepts to examine and suggest enhancements for current products. To enable students to demonstrate their grasp and knowledge of this topic, they are tasked as a team

of 3-4 students (preferably from different majors) to make a presentation on the idea of ID. Each team member picks a product closely associated with their major (the student population in the class is multidisciplinary) and review whether the design is inclusive or not. Each team then discusses the various products and finalizes one to do an in-depth analysis on looking at the

Figure 1: News Article to stress on importance of ID

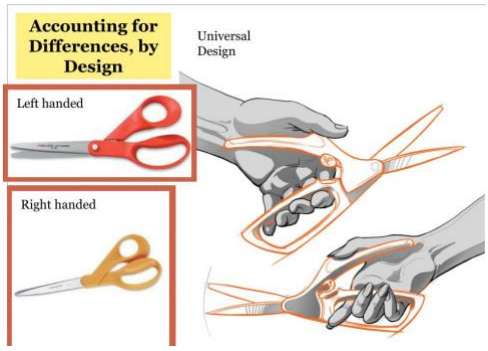

Figure 2: A Universal Design for a pair of scissors

strengths and weaknesses of its design especially from the perspective of inclusivity. Finally, they are also asked to make suggestions on how the design can be improved to make it more inclusive. Figure 3a shows a cochlear implant and some suggestions to make it more inclusive were to make it more discreet, economical and designed for all age groups (6 months – adults). Figure 3b shows a school chair which can be made more inclusive by catering to left-handed and also a chair whose seat height as well as desk height cab be adjusted to cater to a wider audience. Finally, the last two figures (3c and 3d) show a body scanner. Figure 3c shows a body scanner that is widely used at airports. Some improvements to this design are shown in Figure 3d which has a larger opening for wheelchair users and a capability to have privacy filters when needed. These suggestions would make the design more inclusive.

Figure 3: Engineering products that can be improved to be made more inclusive. (a) Cochlear Implant. (b) School Chair. (c) Current version of a Body Scanner and (d) Improved more inclusive version of a Body Scanner.

Future Work

As we develop this activity more, here is our current plan for assessing its success. A bias detection exercise and lively discussion will be the first week's evaluation. This evaluation will use student reflection journals and qualitative feedback. We will also use Likert scale pre-activity surveys to

assess students' understanding and attitudes on DEIBJ and Inclusive Design. Students will be assessed in the second week on their case study analysis and group discussion participation. This evaluation will use participation rubrics and qualitative feedback from open-ended surveys. The assessment will focus on project team progress and collaboration in the third week. The evaluation will include peer assessment, instructor observation, and qualitative weekly reflection analysis. To track attitude changes, we will also deliver mid-activity surveys. Group presentations in the last week will be evaluated using a rubric that considers analysis, redesign originality, and DEIBJ and Inclusive Design principles. Subsequent surveys will assess comprehension and self-confidence after the practice. We plan to triangulate survey, reflection, and project assessment data to understand how activities affect student learning and participation.

Conclusion

This paper offers several ideas to incorporate DEIBJ concepts and inclusive design into a first-year engineering course. Team projects encourage empathy and collaborative thinking by allowing students to consider several perspectives throughout the design process. The lecture on DEIBJ provides a solid platform for case studies and discussions on engineering's social impacts. Integrating prompts and assignments that encourage students to consider underrepresented communities in their design projects could help broaden group activities and technical writing requirements. To integrate these vital concepts into an introductory course requires advanced planning and coordinated and structured efforts. It may also take one or two tries to finalize the module based on student response and performance but the end result is very satisfying and an important first-step in making our students into socially conscious and well-rounded future engineers.

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