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CE for Good: Equity, Justice, and Inclusion in a Highway Design and Construction Course (Case Study)

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Introduction

Colleges and universities need to educate engineering students who are technically competent and ready to contribute to the needs of our increasingly diverse society. In addition to emphasizing graduates' ability to analyze issues in professional ethics, ABET's Engineering Accreditation Commission (EAC) recently added applications of diversity, equity, and inclusion principles to the program criteria for civil and similarly named engineering programs [1]. After two years of optional pilot, EAC adopted the principles of diversity, equity, and inclusion into general Criteria 5 Curriculum and Criteria 6 Faculty in their 2025-2026 accreditation cycle [2]. However, the ABET Board of Directors approved the removal of all references to diversity, equity, inclusion, and accessibility from accreditation criteria and supporting documents; the announcement was distributed via email to ABET institutional representatives on February 19, 2025.

In alignment with the university's Strategic Plan 2030, Central Connecticut State University requires students admitted or readmitted in Fall 2021 and after to complete one equity, justice, and inclusion (EJI) designated course as part of their program of study. Over sixty EJI-designated courses have been developed and offered since then, but engineering courses with an EJI designation remain rare. In response to the past ABET requirements and university policies, the first EJI-designated engineering course – Highway Design and Construction, was offered for the first time in the spring semester of 2023. This case study explains the course design and uses two-year data to evaluate the impacts of EJI topics on student learning and attitudes toward EJI in the context of highway/transportation projects. Student written comments reveal the strengths of this EJI-designated engineering course as well as areas for future improvement.

Course Design

In addition to conventional topics of highway geometric design, a junior-level Highway Design and Construction course contains a module on EJI in highway projects. This EJI module comprises two lectures and two assignments – one individual essay and one team project. Two case studies in New England are presented to students, followed by explanations of how EJI could be related to the engineering code of ethics. In addition, course enrichment activities are intentionally built into this EJI-designated course so students can listen to and learn from industry practitioners. For example, in the spring of 2023, a panel of female construction professionals discussed their career paths, unique challenges, and interesting projects. In the spring of 2024, a group of Connecticut Department of Transportation (CTDOT) engineers presented a few highway projects they worked on and discussed how CTDOT paid more

attention to EJI. Such course designs ensure various methods of instruction, assessment, and assignment types, complementing the EJI course content.

Hartford, Connecticut, and Boston, Massachusetts, are chosen in the EJI lecture presentations because these two major cities have a rich history in social movements and infrastructure improvement, and they are relatively close to the university campus, making in-class discussions familiar and relevant to students. For the first case study, a series of historical maps show how Hartford and its surrounding areas have changed over time in race composition, home value, and landscape, using a few online sources [3], [4], [5], and [6]. A brief presentation on the city's history and interstate system development provides students with the context for EJI discussions, with an emphasis on the negative impacts of highway projects on local communities in the past [7], [8], [9], [10], [11], and [12]. Topics highlighting the lack of EJI in housing and city planning, such as redlining, are also incorporated into the presentation. This case study concludes with proposed plans that Hartford is making for its 400th birthday – Hartford 400 [13], [14], and [15], which leaves students with a sense of correcting past mistakes and heading into a bright future. The second case study in Boston shares many similarities with the previous one, so the focus is placed on its signature project – the Big Dig as well as mitigation measures implemented in this largest and most challenging highway project in the history of the United States [16], [17], [18], [19], [20], and [21].

Students complete their individual essays during this EJI module but have to spend about one month collaborating with one or two team members to further develop their thoughts on EJI in a team project. Thanks to its OpenRoads module, this course is assigned to a classroom with computers. Students are given about fifteen minutes at the end of the two case study lectures to search online, develop their short essay outlines, and ask any questions they may have. This first EJI assignment is promptly graded and returned to students, offering plenty of time and necessary feedback for students to work on their team projects. Students are encouraged to collaborate with peers they know and are interested in similar topics. After teams are officially confirmed, students work outside class while the course moves on to highway geometric design and OpenRoads modules. For both assignments, students are allowed to focus on any EJI topics in transportation, not limited to highway projects. The assignment handout only specifies the paper's length and format, such as font size, line spacing, margins, and how tables, figures, and references are counted to fulfill the length requirement, as well as guidelines on plagiarism and the use of artificial intelligence (AI) text-generation tools.

Student Surveys and Results

Anonymous surveys were conducted using the Blackboard learning management system to collect students' honest opinions on this course's EJI module. Students' responses varied slightly between 2023 and 2024, but the survey results were combined into one data set due to

relatively small sample sizes in both years – fourteen in the spring of 2023 and seventeen in the spring of 2024.

More than half of the thirty-one students were unaware of EJI issues/topics in highway or transportation projects *before* taking this course, indicating the importance of EJI education for civil engineering students. Students who indicated to be aware or somewhat aware of EJI issues/topics were asked to elaborate on what they knew. Quite a few students responded that they were aware of the general problems with highways going through disadvantaged neighborhoods, primarily due to social study classes in high school, political discourses, or what happened in their hometowns. For example, one student wrote, "I was aware of how discrimination is engraved in almost every aspect of society, but learning about how highways were used to separate society and the true power transportation projects have was eye-opening." One comment that is unique in the two class surveys contributed the considerations of EJI in transportation to the political atmosphere our country is currently in. This student commented, "while I agree that many diverse communities were and are greatly affected by transportation systems due to the lack of EJI considerations, I feel that some of the information that is put out there may still be skewed to one side of the political spectrum." This single case shows that EJI education in college has its limits on changing people's minds, especially when this topic is deemed to be related to politics and ideology.

All students agreed this course improved their knowledge/awareness of EJI issues/topics in highway or transportation projects, with 32.3% "strongly agreed", 51.6% "agreed", and 16.1% "partially agreed". More than 95% of the students agreed that this course made them more likely to pay attention to EJI issues/topics in highway or transportation projects in the future, with 22.6% "strongly agreed", 58.1% "agreed", and 16.1% "partially agreed". In other words, only one out of thirty-one students didn't perceive possible changes in their future engineering work that may involve EJI issues/topics.

As for the course enrichment activities, 16.7% of the participating students were "very satisfied", 58.3% were "satisfied", and the remaining 25.0% were "somewhat satisfied" with the panel discussion in the spring of 2023. The evaluation of in-class CTDOT presentations was slightly better, with 17.7% "very satisfied" and 82.3% "satisfied", possibly because of the well-participated Q&A section at the end.

Both student surveys had one open-ended question to solicit comments and suggestions regarding the EJI module of this course. In the first year, one student commented, "I believe that the research and writing component of the class were a bit much." As a result, three questions on the EJI team project assignment were added to the second-year survey. All the seventeen respondents agreed that the EJI team project helped them *better understand* EJI issues/topics in highway or transportation projects, with 17.7% "strongly agreed", 58.8% "agreed", and 23.5%

“partially agreed”. However, two students were unsatisfied with completing the EJI team project while working with their team member(s), indicating possible friction in their teamwork environment. For this survey question, six were “very satisfied”, six were “satisfied”, and three were “somewhat satisfied” in working in small teams. In answering how to improve the EJI team project assignment, one student wrote, "I feel my team members did not do as much research and could have contributed more. I would have been more satisfied writing this paper on my own; However, this is not a reflection of the assignment, but my team”, confirming the challenges commonly seen in college team project assignments. Some insightful and useful student comments include more meeting time during class, a different topic, better directives, and somewhat repetitive but “nice to have a project as such to help with the grades”.

The open-ended question confirmed the positive impacts of the EJI module on student learning and revealed a few constructive comments on how to improve this module in the future. Overall, students enjoyed learning EJI in this course and believed the EJI module was meaningful to their learning and future careers. For example, one student wrote, "I personally had never considered something like highway construction being uninclusive or unfair. This component of the course showed me how some highway projects were designed to be unfairly constructed to members of the surrounding communities. It helped me think about an issue like diversity in a new way that I had not considered”, and another student commented, "I think the topic introduced me to a different understanding of highway design for the future along with and different perspective than most regarding this topic in the future, possibly giving me a "leg up" in the future job market”.

EJI concepts and principles were traditionally overlooked in engineering education, as demonstrated by very limited literature on the pedagogy in engineering disciplines and the single EJI-designated engineering course in a university that requires its graduates to complete one EJI course. A highway or transportation course is one of the best options to cohesively discuss EJI in a civil engineering curriculum, supported by student comments, such as “I believe this was the best course to add the EJI component to. It is relevant to this topic and fit in well to the course”, and “I think that it is valid to include EJI in this course. It did provide me with a better understanding of the impact that transportation projects have on different communities.”

The two writing assignments can be burdensome for some students but can effectively promote active learning when a certain level of freedom is offered. For example, one student commented, "The two assignments provided to us were an effective way for us to learn about EJI... Finally by letting us have the freedom to research the topics of our choice allowed us to enjoy what we were researching.” In addition, one student recommended that the EJI assignments take a more “local” approach and incorporate comparative studies, stating “the EJI report may be more engaging if it focused on something local to us... it would be much more interesting, and in my opinion, rewarding to research the before and after of transportation

projects. To see a change in demographics and its subsequent impacts would be really interesting." It may be a good idea to make such suggestions in the assignment directives, rather than requiring all students to conduct comparative analyses using a local project.

A couple of students made the connection of EJI to the engineering code of ethics and suggested that EIJ "should be a topic referenced throughout the engineering program." One student would like to learn more about the actual process of building a highway, including the permitting process. These comments were not very helpful in refining the EJI module but raised reasonable questions for college professors regarding how to incorporate EJI into other courses in a civil engineering program and how to balance EJI with other topics in a highway/transportation course.

Last but not least, it is crucially important to take a neutral approach to teaching EJI in a civil engineering course. One student wrote, "I have a personal issue with colleges and education in general pushing certain topics onto students. I think that it is important to keep a neutral stance on this topic and let the students form their own unbiased opinions. This class did do a good job keeping neutral position." This comment reflects concerns about EJI being an ideology, but it is from a different student who specifically made such comments, demonstrating the importance of "showing" the EJI concepts rather than "forcing" students to accept the concepts in college engineering education.

Conclusions

This case study presents how EJI is incorporated into a junior-level Highway Design and Construction course in a civil engineering program, how students evaluate this EJI module, and how different elements in this module can be improved based on student surveys. It is clear that civil engineering students appreciate EJI education in college, but instructors need to pay attention to the course design that balances EJI topics with other engineering course materials. It is also crucial that instructors take a neutral position and present historical facts, so students do not feel pressured to accept the EJI concepts.

Student surveys are valuable tools for instructors to collect student feedback and modify the course design. Instructors are encouraged to stay agile in looking into student written comments and considering them in the next round but remain cautious about changing the overall course design based on a few criticisms because, in many cases, different students have different and somewhat conflicting opinions and preferences. It is strongly recommended that instructors utilize various instruction methods, enrichment activities, and assignment types so this course reflects the fundamental principles of EJI.

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