# Board 32: Designing a Graduate Course in Sustainable Transportation and Human Rights with a Student-Centered Approach

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# Designing a Graduate Course in Sustainable Transportation and Human Rights with a Student-Centered Approach

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## Abstract

In recent years, there has been a growing interest in sustainability across various fields, including engineering, due to its impact on the environment and potential to generate solutions. The latest reports from the Intergovernmental Panel on Climate Change (IPCC) have emphasized the importance of implementing environmentally and socially responsible solutions, and the engineering community has responded with both research and educational initiatives to encourage the adoption of sustainable systems (*The evidence is clear: The time for action is now. we can halve emissions by 2030*). Following these efforts, the University of Connecticut (UConn) created a class called “Sustainable Transportation" which is going through a redesign with a focus on the interplay of sustainability, human rights, and transportation infrastructure. In this course, students will delve into land-based transportation systems' impact on the environment, society, and economy. This paper will summarize the lessons learned from redesigning this class, including experiences, challenges, and successes. Our goal with this paper is to serve as a guide for forthcoming multidisciplinary engineering course redesigns using a student-centered approach.

## Introduction

Developing innovative pedagogical frameworks to cultivate a new generation of conscientious engineers knowledgeable of the dynamic intersection of sustainability, transportation, and human rights has become essential in an era of deep climate events and disruption. According to the Intergovernmental Panel on Climate Change (IPCC), environmentally and socially responsible emission reduction solutions are needed. One of those strategies emphasizes how, through sustainable planning and transportation systems, engineers can design walkable, compact cities that will contribute to significant emission reductions. This becomes critical because although world cities are responsible for more than 80% of the gross domestic product and are key engines for development, they also consume over 75% of the energy produced worldwide and account for more than 60% of greenhouse emissions [1].

Furthermore, while the IPCC and other reports highlight an underlying need for environmental conservation and a reduction in consumption patterns worldwide, there are still more than 2 billion people around the world without access to safely managed drinking[1] water and managed sanitation services, around 1.8 billion do not have adequate access to housing, and there are more than 70 million children engaged in hazardous child labor around the world [2]. Based on these challenges, the engineering community has responded with both research and educational initiatives that have adopted the language of sustainable development to support the design, development, and deployment of sustainable systems [3]. In the educational field, this has been reflected in the growth of classes, pedagogical tools, and programs focused on sustainability.

UConn's College of Engineering has adapted a significant shift in its pedagogical approaches to develop interdisciplinary majors and certifications that combine coursework across different disciplines [4, 5]. This shift in pedagogical methodologies aims to prepare students to expand their worldviews, enhance their range of skills, and develop into critical, creative, emotionally intelligent, and interdisciplinary thinkers.

This paper summarizes the redesign of a graduate course focused on sustainable transportation at the University of Connecticut that not only imparts theoretical insights but also discusses practical skills essential for addressing the multidimensional challenges posed by the intersection of sustainability and human rights applied to the field of transportation. The methodology to redesign the course focused on a student-centered approach, a description of the context within which the redesign occurred, and the standards and framework guiding the redesign process. The paper summarizes the lessons learned from redesigning this class, including experiences, challenges, and successes, from the professor's perspective. Our goal with this paper is to serve as a guide for forthcoming engineering course redesigns that explicitly consider the integration of different disciplines, such as human rights, using a student-centered design.

## Background Concepts

### The Concept of Sustainability

Sustainability is a complex and challenging concept due to the multidisciplinary dimensions associated with integrated nature. To better understand this integrated complexity, researchers have delineated three primary streams of thought, each contributing to the comprehensive definition of sustainability. These streams are categorized as: (1) environmental considerations, (2) social dynamics, and (3) economic imperatives [7]. The World Commission on Environment and Development has defined sustainable development as "Meeting the needs of the present without compromising the ability of future generations to meet their own needs" [8]. This

[1] "Safely managed drinking water and sanitation services: Drinking water from sources located on premises, free from contamination and available when needed, and using hygienic toilets from which wastes are treated and disposed of safely."https://www.who.int/news/item/18-06-2019-1-in-3-peoplehttps://www.who.int/news/item/18-06-2019-1-in-3-people-globally-do-not-have-access-to-safe-drinking-water-unicef-whoglobally-do-not-have-access-to-safe-drinking-water-unicef-who

definition reflects an ongoing process that requires ethical responsibility to ensure equity and justice. The interconnected relationship between sustainable development, transportation systems, and human rights becomes apparent by studying their principles and values. Human rights are at the core of the Sustainable Development Goals (SDGs), and 14 out of 17 are, in turn, affected by public transportation in the United States [9]. Furthermore, main concepts such as (a) accessibility, (b) inclusivity, and (c) intergenerational equity have made their way into transportation, emphasizing the critical need for a comprehensive understanding of the long-term consequences of transportation decisions on the environment. At its core, sustainability in transportation underscores the imperative to design, implement, and manage transportation systems in a manner that minimizes negative environmental impacts, fosters intergenerational equity, and ensures economic stability.

## Sustainability Education in Engineering

In this manuscript's context, the significance of sustainability in engineering education emerges as a desire to shape a future generation of ethical and caring professionals. The intricate interplay between sustainability, transportation systems, and human rights underscores the pressing need to incorporate these principles into engineering pedagogy approaches. According to Metzinger et al. and Hall et al. student-centered, active learning pedagogies are perhaps the best approach within the classroom, not just for sustainability development education, but for engineering in general [10, 11].

Incorporating sustainability into engineering introduces a novel perspective by teaching beyond conventional engineering practices and design. This endeavor seeks to cultivate practices and principles aimed at nurturing a society that is both more sustainable and equitable. This educational approach is not solely focused on the immediate benefits for our generation but is driven by the overarching goal of creating a lasting positive impact for generations to come. Integrating sustainability into engineering courses heralds a paradigm shift, offering a fresh perspective that extends beyond conventional engineering norms and design methodologies. At the same time, it incentivizes new engineering development and techniques that could advance the fulfillment of SDGs and basic human rights. Therefore, cultivating a set of principles and practices on sustainability not only contributes to the immediate betterment of society but also lays the groundwork for a sustainable and equitable future based on both engineering solutions that respect human rights. This initiative is driven by a forward-looking ethos, recognizing its potential to foster enduring positive outcomes for the present and future generations [11].

## Human Rights and Transportation

Recognizing the importance of addressing sustainable transportation systems is underscored by the global surge in initiatives dedicated to defining and measuring sustainability [12]. As explained by authors Jeon and Amekudzi, the effectiveness of a sustainable transportation system is measured by its impact on the economy, environment, and social well-being. Integrating a human rights perspective into transportation planning courses will foster understanding of the complex dynamics between transportation systems and societal well-being. Access to an efficient

transportation system that prioritizes pedestrians and focuses on mobility and accessibility is a societal necessity and a human right. In summary, incorporating a human rights perspective enriches the transportation planning class by instilling a sense of ethical responsibility and social consciousness, ultimately contributing to the creation of a more sustainable and inclusive urban environment for all.

Engineering and Human Rights Curriculum at UConn

UConn's College of Engineering and the Gladstein Family Human Rights Institute have joined forces to create the Engineering for Human Rights Initiative. The main objective of this new initiative was to address human rights implications of the most significant challenges in engineering and technology [13]. According to Chacon-Hurtado et al. [14], Engineering for Human Rights is a framework that relies on universal principles to guide ethical obligations and professional norms within the engineering field. Its primary purpose is to (1) reduce risk, (2) improve access to technological benefits, and (3) address harms caused by engineered products or processes. This framework is anchored in five core principles: Distributive justice, Participation, Consideration of duty-bearers, Accountability, and Indivisibility of rights as shown on **Figure 1**. The relationship between the core principles of the Engineering for Human Rights Initiative and Fink's dimensions for significant learning is summarized in **Table 1.**


**Figure 1:** Core principles of the Engineering for Human Rights Initiative proposed by Chacon- Hurtado et al. [14]

**Pedagogy and Class Description**

Following the Common Curriculum at UConn, the newly developed Curriculum is designed to help students learn to be versatile in a rapidly changing world; combine knowledge in innovative ways; apply learning strategies to new contexts, including their major; see local and global patterns

and the interconnectedness of intellectual work; and appreciate how we need each other to tackle today's challenges. The purpose of the course redesign is to (1) develop a student centered learning environment, (2), ensure compliance with the Accreditation Board for Engineering and Technology standards (3) foster critical thinking by empowering students to question, discover and explore the socio-technical systems around them, (4) ensure compliance with the Graduate Certificate of Human Rights by discussing fundamental concepts of human rights and how this framework could be used to assess the social impact of transportation engineering projects and, (5) and, to integrate UConn's initiative on clean energy and transportation, while also providing students with quantitative tools for real-world assessments. To meet the requirements and ensure that the course promotes student-centered learning, a framework based on (Finks, 2013) called "*Designing Courses for Significant Learning*" is employed as our design methodology [6].

## Course Design

The main goal of the redesign proposed in this paper was to foster a learning environment that embraces critical thinking and ethical responsibilities. Critical thinking is defined as a state of mind that continually questions '*Who? What Where? How? Why?'* [15]. Drawing upon this definition and utilizing Fink's Taxonomy for Significant Learning, we employed a backward design approach to develop our course with a student-centered focus, implementing the six dimensions outlined by Fink [6] **Figure 2**:

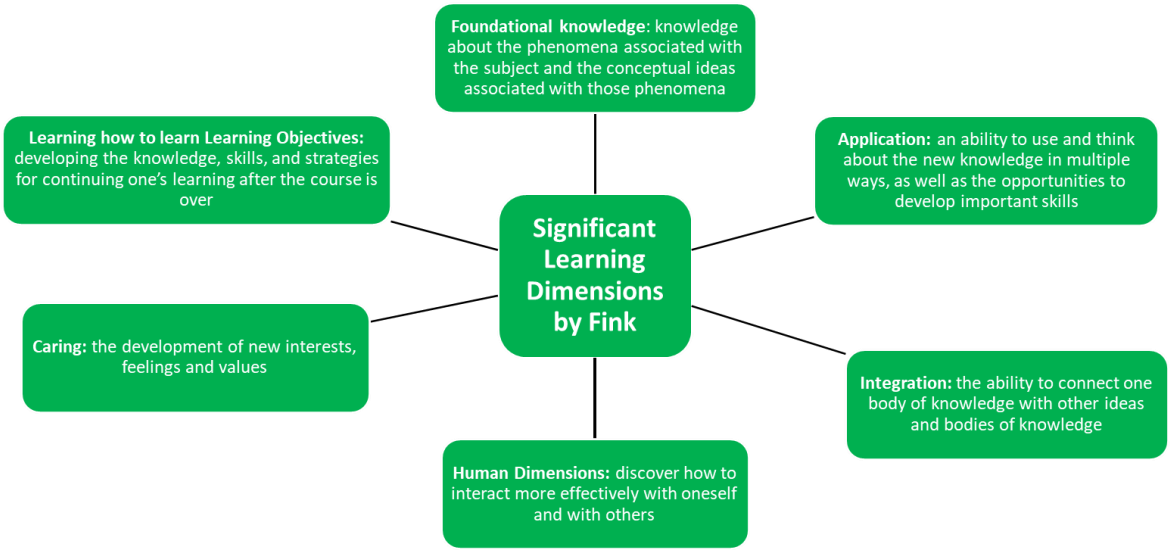


**Figure 2:** Author's interpretation of Fink's Taxonomy for Significant Learning Dimensions

Following Fink's instructional approach, the initiation of our course planning process involved a comprehensive exploration of the situational factors. This exploration encompassed an examination of: (1) the specific context of the teaching and learning situation, (2) general context of the learning, (3) nature of the subject, (4) characteristics of the students and (5) characteristics of the teacher. Equipped with a deep understanding of these contextual intricacies, the subsequent phase of our methodology involved the meticulous formulation of learning objectives and corresponding assessments. Our course design strategy was as described in **Table**

**1**:

**Table 1:** In class activities created to foster critical thinking using Fink's dimensions for significant learning and their relationship to the core principles of Engineering for Human Rights proposed by Chacon-Hurtado et al. [14]

| **Learning Objective** | **Significant Learning Dimension + Engineering for Human Rights Principle** | **Class Activity** |
|---|---|---|
| Explain the concepts of sustainability, sustainable transportation, environmental and social impacts of transportation, and how those are embedded in socio-technical systems | **Foundational Knowledge + Participation** | Students create concept maps illustrating the core principles of sustainable transportation, emphasizing how each principle connects and contributes to the overall concept of sustainability in transportation. |
| Analyze core economic development, social and environmental impacts of transportation projects and use results to make decisions about the best project alternative for transportation projects | **Application + Consideration of duty-bearers** | Problem solving exercises and peer review solutions |
| Describe how unsustainable transportation systems are social determinants of societal issues such as food insecurity, lack of health, and poverty | **Integration + Indivisibility of rights** | Given a real-world example of an unsustainable transportation system, students will analyze it using quantitative and qualitative methods learned in class and present their findings |
| Come to see themselves as engineers who are aware about the limitations of transportation policies | **Human Dimensions + Distributive Accountability** | Divide the class into groups, each representing a stakeholder (e.g., government, environmental Organizations, citizens). Students prepare arguments advocating for sustainable transportation policies and engage in a debate |

| | | |
|---|---|---|
| Understand the ethical responsibilities of engineers with design, effectively considering socio-technical context of their projects | **Caring + Distributive Justice** | Divide the class into groups, assign an ethical dilemma related to transportation engineering to each group, and encourage them to discuss and propose solutions. |
| Identify important resources of information on the advancements in transportation and sustainability to stay up-to-date and well-informed, and create a learning plan to continue educating on the subject and apply it as part of their career path | **Learning How to Learn + Consideration of duty-bearers** | Students will gather various sources related to sustainable transportation (articles, websites, and academic papers). And will be asked to analyze and rank the sources based on reliability, relevance, and credibility. They should justify their rankings, emphasizing the importance of credible information in decision-making |

To nurture critical thinking skills throughout the course, we have designed class activities and assessments that not only assess comprehension but also encourage students to interrogate the rationale behind their learning. By prompting students to question, analyze, and evaluate concepts independently, these assignments serve as catalysts for the development of robust critical thinking skills. Our aim is to guide them in forming an impartial perspective grounded in factual evidence. To do so, we have divided the class into 5 major areas of grading: (1) homework and discussion boards, (2) a midterm exam, (3) weekly class participation, (4) project analysis and presentation and (5) a final term paper.

## Conclusion and Next Steps

In conclusion, the class discussed herein is an effort to address the imperative need for innovative pedagogical frameworks to educate future engineers capable of navigating the complex intersection of sustainability, transportation, and human rights. With escalating climate events and global disruptions, the call for environmentally and socially responsible solutions, as emphasized by the Intergovernmental Panel on Climate Change (IPCC), has never been more urgent. The challenge lies in designing sustainable transportation systems that not only mitigate environmental impact but also uphold human rights principles, particularly in ensuring equitable access to essential services like water, sanitation, and housing.

This paper symbolizes the first stage of our work. By employing a backward design methodology and drawing upon Fink's Taxonomy for Significant Learning, the course aims to foster critical thinking skills among students. Through a diverse range of class activities and assessments, students are encouraged to question, analyze, and evaluate concepts independently, thereby cultivating an impartial perspective grounded in factual evidence. Ultimately, this endeavor seeks to empower students to become conscientious engineers equipped with the ethical principles and interdisciplinary mindset necessary to tackle the complex socio-technical issues of our time. In the future, we plan to evaluate the effectiveness of the class from the students' perspective.

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learning environments that are student centered and that focus on breaking down pre-received notions on how teaching should be to explore what teaching could be. Stuart's recent co-authored publication Music-making in U.S. Prisons: Listening to Incarcerated Voices, explores how the art and science of teaching and learning is so much more than presenting content, it is about connecting with our humanity.