Engineering Educators Bringing the World Together
2025 ASEE Annual Conference & Exposition
Palais des congrès de Montréal, Montréal, QC • June 22–25, 2025 ASEE
Paper ID #45716

BOARD #156: Transforming Civil Engineering Education: Integrating the EOP Framework Across Four Courses

Dr. Nadia Al-Aubaidy, Norwich University

Dr. Nadia Al-Aubaidy is an Associate Professor in the David Crawford School of Engineering at Norwich University. She holds a Ph.D. in Civil Engineering from The University of Texas at Austin, where she also earned a certification in Dispute Prevention and Resolution from the School of Law. Additionally, Dr. Al-Aubaidy is a LEED Green Associate. In recognition of her outstanding teaching, she received the 2024 ASC Regional Teaching Award for Region #1 (Northeast). Dr. Al-Aubaidy is dedicated to advancing the architecture, engineering, and construction management curricula by incorporating cutting-edge technologies such as Virtual Design and Construction (VDC)/Building Information Modeling (BIM), Artificial Intelligence (AI), and other innovations to enhance education in these fields.

©American Society for Engineering Education, 2025

Transforming Civil Engineering Education: Integrating the EOP Framework Across Four Courses

Dr. Nadia Al-Aubaidy, Ph.D.; LEED Green Associate, Mark Atwood, PE; Dr. Adam Sevi, Ph.D.; PE.

Norwich University- June, 2025

Abstract

Sustainability is becoming increasingly essential in engineering careers. Thus, engineering educational institutions must integrate sustainability into their curricula to prepare future engineers capable of designing and implementing solutions that meet human demands without depleting the planet's resources for future generations. This trend is driven by growing environmental concerns, regulatory changes and compliance, industry standards, and market demand. As a result, the (EOP) Engineering for One Planet Framework has evolved to respond to this urgent need and elevate engineering education to the highest level by guiding academia on integrating sustainability into the course curriculum.

Objectives

This study aims to infuse the vision, goal, and tools developed in the EOP Framework into the content of four existing courses to enhance the educational outcomes of the Civil Engineering and Construction Management Department. By aligning curricula with the ABET program criteria through the EOP Framework, academic institutions can ensure that their programs meet rigorous standards and equip students with the essential skills and knowledge required for sustainability. The guiding research questions are: (1) What are the themes of students' perceptions of integrating sustainability in the (AEC) architecture/engineering/construction industry? (2) What are the themes of students' perceptions of incorporating sustainability into the course curriculum?

Methodology

The EOP Framework was integrated into the syllabus of four courses. Curricula were aligned with the ABET program criteria: (1) Introduction to Engineering Course (Freshman Level), (2) Building Information Modelling and Integrated Practices Course (Sophomore Level), (3) Engineering Economics and Decision Analysis Course (Junior Level), (4) Capstone Design Project Course (Senior Level). Various engineering teaching methods were embedded in the curriculum design to solve complex sustainability problems, including lectures with interactive elements, real-world projects, computer-based simulations, field trips, and guest speakers. The research method starts with a thorough literature review and includes two questionaries and Photovoice templates to collect qualitative data. The first questionnaire is given to students before the integration of sustainability, and the second one is filled out after the integration is completed. After completing the learning activities in sustainability, students are asked to fill in Photovoice templates. Photovoice is a participatory action research (PAR) in which researchers work collaboratively with the participant subject population to collect data, reflect, and take action. Data obtained are analyzed using descriptive statistics and thematic analysis, a fundamental qualitative method for finding patterns within the data set using a step-by-step process.

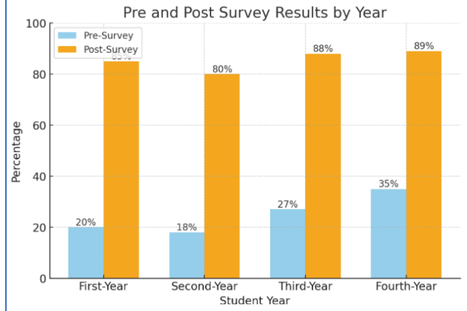
Seven research-based instructional strategies, including Project-Based Learning (PBL), Collaborative Learning, Experiential Learning, Problem-Based Learning (PrBL), Interdisciplinary Learning, Inquiry-Based Learning, and Authentic Assessment, were implemented into four courses in the Fall of 2024. The EOP Framework consists of 92 essential sustainability-focused learning outcomes, 46 identified as "core" and 46 as "advanced". Seven "cores" of the EOP framework were selected to integrate into the four courses at Norwich University.

Topics	EOP Core or Advanced
Systems Thinking	**Core#3:** Apply relevant concepts from required disciplines to the study of real-world problems and their solutions with empathic and ethical consideration for communities/societies, environmental justice, and cultural awareness.
Environmental Literacy	**Advanced#5:** Weigh energy-use decisions based on an understanding of impacts and consequences.
Environmental Impact Assessment	**Core#2:** Recognize current eco-labeling systems and certificates (i.e., EPEAT, Energy Star) for sustainable production and consumption.
Materials Selection	**Core#6:** Select materials for design alternatives and trade-offs that enable a long functional lifetime, have net zero greenhouse gas emissions impact, either minimal or no environmental and social harm, or are restorative to social, cultural, and environmental ecosystems.
Design	**Core#1:** Execute technical analyses to choose strategies that maximize the positive and minimize the negative environmental and social impacts in order to achieve design goals.
Critical Thinking	**Core#1:** Define problems comprehensively with consideration of consequences, unintended and intended. **Core#3:** Report understanding that their values are both shaping, and being shaped, by the designs, technologies, innovations, etc., they create and scale.
Communication & Teamwork	**Core#1:** Demonstrate ability to sell, pitch, and explain ideas and advance learning. • Demonstrate ability to work well with others, across organizations, disciplines, and cultures. • Advocate for underrepresented and intentionally marginalized or excluded groups. • Support organizational and societal change. • Develop team effectiveness.

Methodology

In the **Introduction to Engineering Course**, students studied water efficiency in green buildings and worked on a project to retrofit an existing campus building's water systems to meet green building standards. Their findings were presented through a written report and PowerPoint presentation.
The **Building Information Modeling and Integrated Practices Course** taught students how to design sustainable building sites. They conducted environmental site assessments and created a 3D BIM model of the site. Students analyzed and presented their data through reports and presentations.
In the **Engineering Economics and Decision Analysis Course**, students assessed the financial feasibility of solar panels in green buildings, developing models to compare the life cycle costs of photovoltaic panels and conventional energy sources. This enhanced their critical thinking and decision-making skills.
The **Capstone Project Course** involved senior students working on green building projects, aiming to achieve LEED Silver certification. They researched materials, equipment, and approaches and presented their findings through reports, PowerPoint slides, and posters.
The program included a **guest speaker** and a **field trip** to a LEED Silver-certified building.
This curriculum equipped students with theoretical and practical knowledge in sustainability, water efficiency, economic decision-making, and green building certification, preparing them for real-world applications in sustainable construction.

Research Results



At the semester's end, research revealed that students' perceptions of integrating sustainability in the AEC industry and into the course curriculum improved. Different core themes related to this study were also spotted and displayed.

Research Results

Summary of Research Results: Student Reflections on the Integration of the EOP Framework

1. Understanding Sustainable Construction (Curriculum Impact)

Students recognized the value of integrating sustainability into the course curriculum, emphasizing how it provided a fresh perspective on construction projects. Key takeaways included:

Sustainable construction is not only environmentally responsible but also cost-effective in the long run.

Life-cycle cost analysis helped students understand that sustainable investments, such as solar panels and efficient insulation, lead to financial savings over time.

Water conservation methods, such as low-flow fixtures, contribute to both sustainability and reduced operational costs.

The curriculum encouraged students to view construction projects through a sustainability lens, broadening their understanding beyond profit and structural integrity.

2. Improved Student Performance in Sustainable Construction

The integration of sustainability principles positively impacted student engagement and performance. Key themes included:

Hands-on experiences, such as field trips to green buildings, reinforced theoretical concepts.

Exposure to real-world sustainable practices (e.g., using local materials, recycling scrap metal, and enhancing insulation) helped students make informed decisions in project planning.

The curriculum fostered critical thinking, particularly in material selection, energy efficiency, and water management.

Learning from industry professionals provided valuable insights into practical applications of sustainability.

3. Shaping Student Attitudes Toward Sustainability

Students expressed a shift in their perspective on construction, recognizing the broader impact of sustainable practices:

The curriculum challenged the misconception that sustainability is always expensive, showing how it can lead to cost savings.

Sustainability became an essential consideration for future career choices, influencing students to incorporate green practices into their professional work.

Students acknowledged that sustainable construction goes beyond technical skills, requiring a mindset change toward long-term environmental responsibility.

4. Engaging with Real-World Construction Projects (Interdisciplinarity)

Students developed a more holistic approach to construction planning by integrating sustainability:

They became more aware of water management strategies, air quality considerations, and energy efficiency measures.

Sustainability encouraged creative problem-solving, allowing students to explore innovative ways to enhance project outcomes.

Understanding interdisciplinary aspects of construction helped students engage more effectively in real-world projects.

Research Results

5. Reflection on Course Effectiveness (Debriefing & Lessons Learned)

Students highlighted both strengths and challenges in the course:

Engaging labs and assignments enhanced learning, with practical experiences like concrete testing and floodplain analysis being particularly impactful.

Challenges included scaling and layout errors in site planning exercises, which provided learning opportunities for future improvements.

Students recognized the importance of time management, emphasizing the need to start assignments earlier to improve performance.

6. Professional and Technical Skill Development

The integration of sustainability fostered both technical and professional growth:

Technical Skills: Concrete testing, soil classification, stream flow calculations, and traffic volume analysis.

Professional Skills: Collaboration, teamwork, communication, and decision-making.

These skills are essential for engineers as they navigate real-world challenges in sustainable construction.

Conclusions

The integration of the EOP Framework significantly enhanced students' understanding, performance, and attitudes toward sustainability in construction. By combining theory with hands-on experiences, the curriculum empowered students to apply sustainability concepts in their future careers, fostering a generation of engineers committed to responsible and efficient building practices.

This study advances interdisciplinary learning experiences in engineering curricula by adapting the EOP Framework and ABET Program criteria. In addition, this study can be applied to other engineering majors and courses and replicated by other institutions' instructors. This study concludes with recommendations for improving the curriculum design and student performance. It also recommends further studies in sustainability in engineering using different research methods and investigating this study topic in depth.

Future Research

1. Longitudinal Study on Knowledge Retention and Application

Investigate how well students retain sustainability concepts after graduation and how they apply them in professional settings.

2. Comparative Analysis Across Institutions

Compare the effectiveness of the EOP Framework in different universities with varying curriculum structures.

Acknowledgments

ASEE-EOP (Engineering for One Planet)

Lemelson Initiative on Environmental and Social Sustainability in Engineering Education

Contact Information

nalaubai@Norwich.edu

RESEARCH POSTER PRESENTATION DESIGN © 2015
www.PosterPresentations.com