

# Embedding the Engineering for One Planet (EOP) Framework through Sustainability-Focused



## Activities in Mechanical and Aerospace Engineering Courses



Dr. Gurudutt Chandrashekar, Dr. Rizacan Sarikaya, Dr. Max Gong; Trine University, Angola, IN

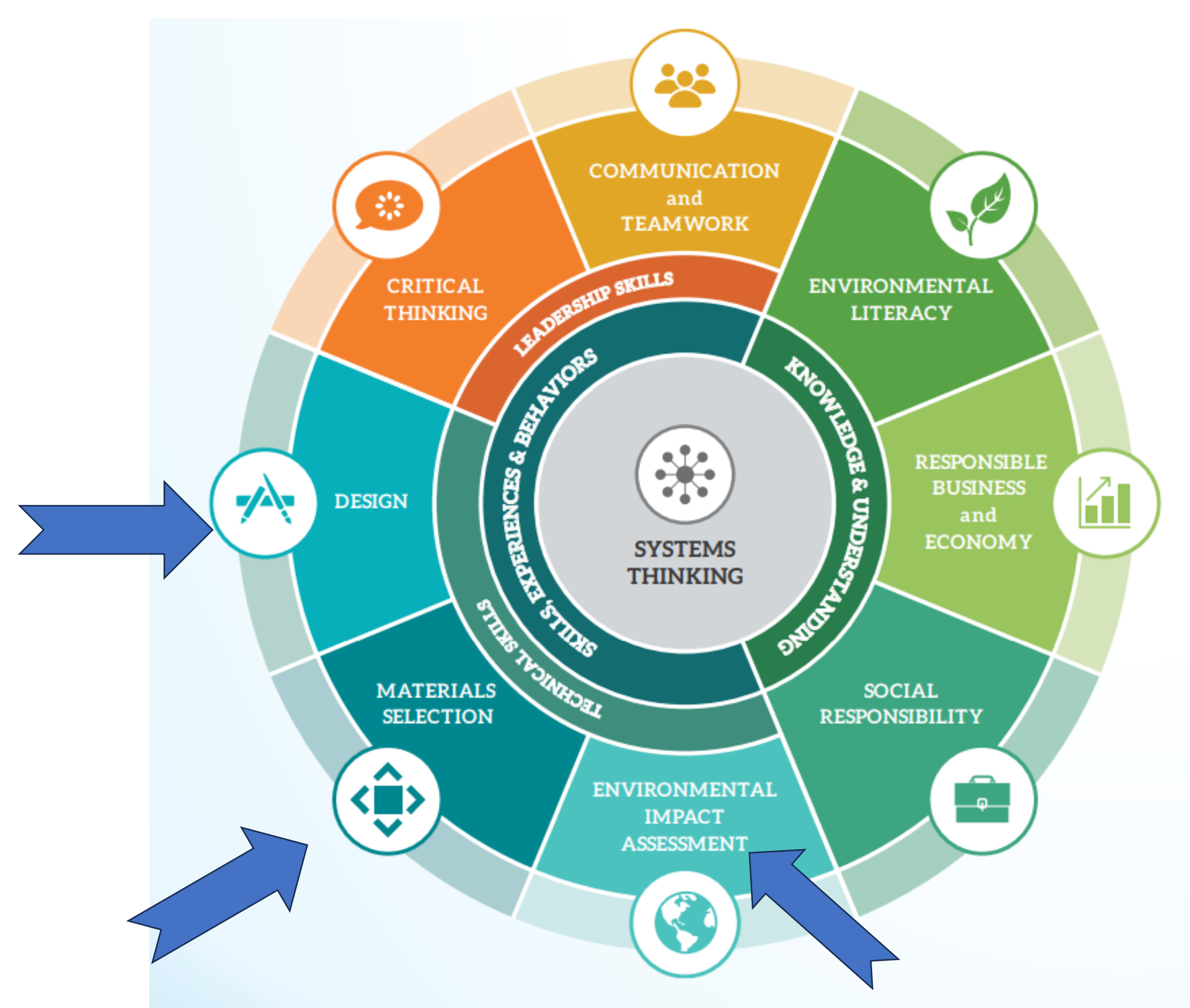
### ❖ Background and Motivation

- Sustainability is a key requirement in engineering practice
- Aligns with ABET criterion 3 – consideration of environmental and societal factors in design solutions [1]
- EOP framework provides a clear framework for sustainability integration into engineering curriculum [2]
- Prior ASEE conference proceedings [3-5] have shown the efficacy of EOP aligned activities in enhancing students' sustainability awareness

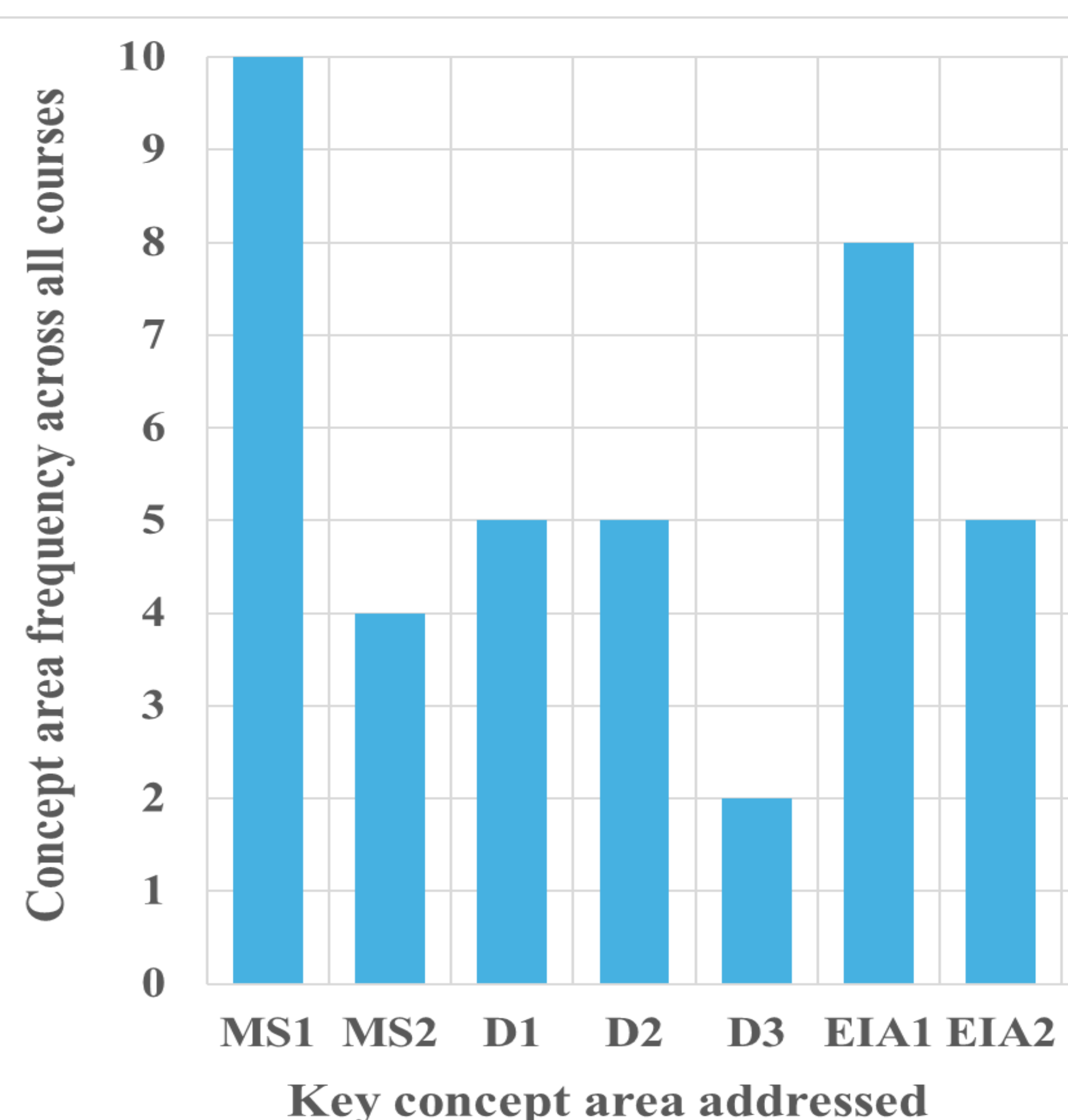
### ❖ Course Implementation and Alignment with EOP Framework

- Sustainability activities were implemented by 3 engineering faculty across 5 courses – (a) Introduction to Engineering, (b) Engineering Materials, (c) Machine Component Design, (d) Computer Aided Machine Design, and (e) Aerospace Composites.
- These activities emphasize sustainability through three EOP topic areas: (a) Design, (b) Materials Selection, and (c) Environmental Impact Assessment

| EOP-MGP Topic area                    | Key concept areas from the topic area learning outcomes   |
|---------------------------------------|---|
| Design (D)                            | Lightweighting (D1), Design for repairability and durability (D2), Design for disassembly (D3)                          |
| Material Selection (MS)               | Material impact evaluation through embodied energy calculations (MS1), Design with lower impact natural materials (MS2) |
| Environmental Impact Assessment (EIA) | Carbon footprint calculation (EIA1), Life cycle assessment (EIA2)   |



EOP Framework [2]



Concept areas addressed across courses

### ❖ Assessment of Student Learning Outcomes

- Retrospective pre-post survey and reflective questions administered in Nov-Dec 2025
  - Total of 192 students across 5 courses answered the survey.
- Retrospective Pre-post Survey**
- Please rate each statement twice — Before (start of course) and After (end of course). Score: 1=Strongly Disagree, Score:5 =Strongly Agree
1. I understand how sustainability principles—such as carbon emissions, energy use, and recycling—apply to mechanical design decisions.
  2. I can assess environmental trade-offs when selecting materials or designing mechanical components.
  3. I can quantify the environmental impact of materials and processes using data such as embodied energy and carbon footprint.
  4. I understand how to integrate sustainability metrics into the engineering design process.
  5. I am able to balance technical performance with environmental impact when making design decisions.
  6. I believe engineers have a responsibility to minimize environmental impact through their design choices.
  7. I believe sustainability can be incorporated into technical design without compromising performance.
  8. I am motivated to continue learning about sustainable engineering design practices beyond this course

### ❖ Results and Conclusion

- Normalized Average Gain (%) =  $\text{Average}(\text{Score}_{\text{after}} - \text{Score}_{\text{before}}) / 4 \times 100$
- Gain% data bars corresponding to each question is shown below.

|    | Introduction to Engineering | Engineering Materials | Machine Component Design | Computer Aided Machine Design | Aerospace Composites |
|----|-----------------------------|-----------------------|--------------------------|-------------------------------|----------------------|
| Q1 | 32.7                        | 44.3                  | 50.6                     | 46.9                          | 50                   |
| Q2 | 36                          | 63.6                  | 52.2                     | 46.9                          | 51.9                 |
| Q3 | 37.7                        | 85.2                  | 64.4                     | 50                            | 72.1                 |
| Q4 | 39                          | 64.8                  | 55.6                     | 52.1                          | 51                   |
| Q5 | 32                          | 62.5                  | 51.1                     | 41.7                          | 54.8                 |
| Q6 | 20.9                        | 25                    | 24.4                     | 17.7                          | 29.8                 |
| Q7 | 21.6                        | 20.2                  | 28.9                     | 24                            | 36.5                 |
| Q8 | 19                          | 27.4                  | 30                       | 41.7                          | 36.5                 |

### ❖ Conclusion

- Largest gains occur in quantitative and analytical skills (Q1–Q5).  
*Applying, assessing, and measuring sustainability in engineering design*
- Smaller gains occur in mindset- and motivation-oriented items (Q6–Q8).  
*Personal belief, motivation, and long-term adoption of sustainability thinking*

### Future work

- Sustainability activities in Vehicle Structures (Spring 2026) and Capstone Design (2026-2027)
- Sustainable Composites Innovation Lab (Fall 2027); Sustainability Society (Starting Fall 2027)

### References

- [1] ABET Accreditation Criteria. ABET Engineering Accreditation Commission, *Criteria for Accrediting Engineering Programs*, 2024–2025. Baltimore, MD: ABET, 2024. Available: <https://www.abet.org/accreditation/accreditation-criteria/>
- [2] Engineering for One Planet (EOP) Framework. ASEE and The Lemelson Foundation, *Engineering for One Planet (EOP) Framework*, 2023. Available: <https://engineeringforoneplanet.org/eop-framework/>
- [3] Enhancing Civil Engineering Curriculum with EOP. A. S. Welker, H. M. Harmon, and L. K. Murray, "Enhancing Civil Engineering Curriculum with Engineering for One Planet (EOP): Insights from an EOP mini-grant project," in *2025 ASEE Annual Conference & Exposition*, Montreal, Quebec, Canada, Jun. 2025. Accessed: Nov. 30, 2025. [Online]. Available: <https://peer.asee.org/enhancing-civil-engineering-curriculum-with-engineering-for-one-planet-eop-insights-from-an-eop-mini-grant-project>
- [4] Cultivating a Sustainable Mindset. A. T. Kwaczala, D. Jaiswal, and L. K. Murray, "Cultivating a Sustainable Mindset in Undergraduate Engineering through the Engineering for One Planet Framework," in *2024 ASEE Annual Conference & Exposition*, Portland, OR, USA, Jun. 2024. Accessed: Nov. 30, 2025. [Online]. Available: <https://peer.asee.org/cultivating-a-sustainable-mindset-in-undergraduate-engineering-through-the-engineering-for-one-planet-framework>
- [5] Integrating Sustainability into Materials Courses. M. H. Al-Haik and H. M. Harmon, "Integrating Sustainability into Materials Courses through the Engineering for One Planet Framework," in *2025 ASEE Annual Conference & Exposition*, Montreal, Quebec, Canada, Jun. 2025. Accessed: Nov. 30, 2025. [Online]. Available: <https://peer.asee.org/integrating-sustainability-into-materials-courses-through-the-engineering-for-one-planet-framework.pdf>